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FIFTY-NINTH

ANNUAL REPORT OF THE SECRETARY

OF THE

MASSACHUSETTS

STATE BOARD OF AGRICULTURE,

TOGETHER WITH THE

TWENTY-FOURTH ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

1911.

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The State Board of Publication.

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STATE BOARD OF AGRICULTURE, 1912.

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Housatonic,	R. H. RACE of North Egremont,	1915
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Martha's Vineyard,	JAMES F. ADAMS of West Tisbury,	1913
Massachusetts Horticultural,	WILFRID WHEELER of Concord,	1915
Massachusetts Society for Promoting Agriculture,	N. I. BOWDITCH of Framingham,	1915
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Middlesex South,	JOHN J. ERWIN of Wayland,	1914
Nantucket,	HERBERT G. WORTH of Nantucket,	1915
Oxford,	WALTER A. LOVETT of Oxford,	1913
Plymouth County,	AUGUSTUS PRATT of Middleborough (P. O. North Middleborough),	1914
Spencer (Farmers' and Mechs.' Ass'n),	WALTER C. BEMIS of Spencer,	1913
Union (Agricultural and Hort'l),	SYLVESTER H. PEEBLES of Blandford,	1913
Weymouth (Agricultural and Ind'l),	THERON L. TIRRELL of Weymouth (P. O. South Weymouth),	1915
Worcester,	B. W. POTTER of Worcester,	1914
Worcester East,	GEO. F. MORSE of Lancaster,	1915
Worcester North (Agricultural and Driving Association),	L. E. FLETCHER of Fitchburg,	1915
Worcester Northwest (Agricultural and Mechanical),	ALBERT ELLSWORTH of Athol,	1913
Worcester South,	WILLIAM E. PATRICK of Warren,	1913
Worcester County West,	JOHN L. SMITH of Barre,	1914

The Commonwealth of Massachusetts.

THE FIFTY-NINTH ANNUAL REPORT

OF THE

SECRETARY

THE

STATE BOARD OF AGRICULTURE.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

The year 1911 has been a very hopeful one in agriculture in Massachusetts. Notwithstanding a somewhat unfavorable season, our farmers have awakened to their opportunities to a greater degree than ever before, and now look upon the business of farming as a satisfactory and paying proposition rather than a losing one, as has been the tendency in past years. This has been due to the development of special lines of work, notably apple growing, which have pointed the way to profit and pleasure through specialization and catering to our home markets. The interest in apple growing, and to a lesser degree that in other fruits, has shown a steady and sound progress since its awakening a few years ago, and everywhere more attention is being paid to old orchards, too long neglected. Thrifty orchards are being increased in acreage and new ones set out in numerous instances.

Another factor in the increased interest in the business of farming in Massachusetts is the fact that capital is at last awake to the knowledge that here in New England we have the best opportunity for investment in agricultural property of any portion of the United States. The free lands of the west have

been long since taken up, except where they must be reclaimed by irrigation, and capital has of recent years turned its attention to high-priced lands in the west and northwest, only to find that the opportunity for profit was diminished, often to the vanishing point, by the high prices compelled by the expense of reclaiming such lands and bringing them into condition to be used for agricultural purposes. The south and southwest have had their turn as the goal of the capitalist interested in agriculture, and to-day the turn of New England has come. It is apparent that at present prices, or indeed any prices reasonably close to them, agricultural land can be had here, often with good buildings and bearing orchards, at prices much below those of other sections. Adding this to the advantage given by the great markets which lie at our doors, and which are ours if we will but meet them by supplying the grade of goods called for, makes the proposition very attractive from the standpoint of capital seeking investment on farming lines. All over the New England States you will find men who have recognized this, have already located, and are engaged in building up some sort of a farm business, most often along some line of fruit growing. This has stimulated a brisk demand for farm property, with the inevitable result that our farmers have come to hold their property at higher prices, are less inclined to sell and are coming to believe, most often, that their farms are worth as much to them as to others, and hence to take a more hopeful view of the business from every angle.

From the standpoint of crop production the year has not been an especially successful one. The drought of midsummer, coming as it did for the third successive year, and with soil moisture well depleted and streams and springs low, had a bad effect on many crops. The late rains have done a great deal to remedy this condition, and with reasonable rainfall another growing season there seems to be no reason to anticipate any further evil effects from the drought of this year. The corn crop suffered especially from the drought, its development being so slow that many fields were very severely injured by the frosts of mid-September, although they did not come at an unusually early date. Much corn was still standing, awaiting further maturity, and was often rendered valueless for grain and

severely injured for the silo. Pastures suffered severely from the drought, and feeding at the barn began at an unusually early date. The rains came too late to cause much feed to start in the pastures, and the only effect was to put them in good condition for another season. These factors, combined with the short hay crop and the high prices of grain and hay, have made the season far from profitable for all except the most careful and scientific dairymen, and this in spite of prices which averaged well for the year. The milk contractors made a drastic cut in prices for milk in the early part of the season, so that many dairymen sold or dried off their cows, thus reducing the amount of milk produced, and, with the effects of the drought, compelling a substantial increase later in the season. This experience should show those engaged in handling milk that it is not to their advantage to force the price of milk below the point of reasonable profit to the farmer. Cows were generally lower in price at the farm, though there was not a corresponding drop in prices at points where milch cows were offered for sale to those farmers who rely on purchase to supply their herds.

Apples were a light crop in most sections, but unusually fair and free from blemishes, due largely to the increased care given them in the way of spraying, fertilization, cultivation and pruning. The increase in the amount of spraying done in the State is notable, there being many sections where the farmer who does not spray is the exception, whereas a few years ago the reverse was the case. Many young orchards have been set out, either independently or with older orchards, and with proper care there is no better investment at present. In fact it is my opinion that the opportunity offered by apple raising is greater than that in any other line of agriculture and greater than that in almost any line of manufacturing.

Market gardeners in general did very well during the year, for the increased price received for most crops made up for the shortage in yield. Those market gardeners who practised some system of overhead irrigation were especially successful, keeping their yields well up to the normal, and this line of work is increasing with every year. Onions were a light crop, but brought good prices, though hardly high enough to offset the

loss in yield. Tobacco was a good crop, well secured, except where damaged by frost, there being an unusual amount suffering in this way. Prices, as far as recorded, ruled high. Cranberries were a light crop, with high prices. The prices for poultry and eggs ruled high throughout the year, fresh eggs being especially profitable during the winter season, and despite the high prices of grain our poultrymen must have had a successful season.

Legislation of 1911.

The recommendations of this Board for legislation were well received by the Legislature of 1911, considered as a whole. As a result of the session the appropriation for extra clerical assistance and lectures before the Board was increased from $800 to $1,600; the work of apiary inspection was placed on a permanent basis, with an annual appropriation of $2,000; the reprinting of the farm catalogue was provided for, with an appropriation of $1,500; the laws in relation to the killing of wild deer remained as in the year previous; the appropriation for the dissemination of useful information in agriculture was increased $1,000; and a special resolve was passed increasing the powers of the State Inspector of Nurseries, and making a total appropriation for the work of $12,000. The only recommendations of the Board which did not result in more or less complete favorable legislation were those providing for a law authorizing local boards of health to issue permits for the sale of milk and cream, and to make regulations governing its production, transportation and sale, which passed the Legislature and was vetoed by the Governor; that placing the work of the cattle bureau under the Board in fact as well as in name; and the bill introduced by special vote of the Board at its annual meeting to provide for a consulting orchardist. Other acts for the benefit of agriculture were passed, or failed of passage, and will be taken up under the proper headings.

Milk Legislation.

There was very little put upon the statute books at the last session in the way of milk legislation, though seldom has there been a year when so much was attempted. The most important measure of the year which failed of passage because of the

executive veto was the so-called Ellis milk bill. This was a most pernicious measure, providing as it did for inspection of milk producers in Massachusetts, and, in the opinion of your secretary, and that of many others perhaps better qualified to form an opinion as to the legal effect of the bill, utterly failing to properly provide for like inspection for the milk producers of other States. In addition there were numerous objections to the bill in question, notably that it provided for inspection primarily for the benefit of the metropolitan district at the expense of the people of the whole State, producers as well as consumers; provided a uniform system of inspection throughout the State, regardless of the needs of various communities, which differ as their supplies differ; and placed too much stress on the inspection of barns and equipment, on the theory, long since exploded, that these are controlling factors in the production of clean milk. As has been shown again and again, the man is the chief factor in the production of clean milk. A clean man can make clean milk under adverse conditions, and a dirty man can never make clean milk, no matter what his equipment may be. The proponents of this bill should stop to consider that more can be done to induce dairy farmers to make clean milk by offering legitimate rewards than can be done by beating them over their heads with the inspection club or any other. The call for a uniform standard of inspection is also based on wrong premises. There should be no uniform standard of inspection. It may very well be that the standard applicable to Boston would not do at all for Brockton or Worcester, while the standard for those cities might not be at all suited to the needs of towns like Greenfield or Westfield. What is really wanted is a reduction of the number of inspecting bodies, not a uniform system of inspection with the same number of parties at work.

In spite of these very manifest objections, which were all brought to the attention of the committees who had the bill under consideration and of the Legislature as a whole, the bill, which would, in our opinion, have dealt a severe blow to the dairy industry of Massachusetts, was duly passed by both branches, and only prevented from becoming a law by the veto of the Governor. This bill was very persistently, skillfully and

expensively lobbied, though along perfectly legitimate lines, and every means possible taken to cloud the issue. This Board protested against its receiving the approval of the Governor, approved his action in vetoing it, and requested the Legislature to sustain the veto, which result was duly brought about.

This Board is as desirous of seeing the milk supply improved as is any other body of good citizens, but our method is not that of the supporters of the so-called Ellis milk bill. We recommended last year a bill to provide for the placing of the inspection of the production, transportation and sale of milk and cream in the hands of local boards of health, with authority to issue permits for such sale and to forbid the sale of any milk or cream produced, transported or kept under conditions not approved by said boards of health. This allows for full inspection by the body most interested, namely, the representatives of the people who are to consume the milk in question, and these local boards of health are more closely in touch with and in better sympathy with their milk producers than any other organization can be. Further, it puts the expense where it belongs, — on the community which is to receive the benefit.

The Board, at its special meeting, at Barre, December 5, endorsed and reaffirmed this bill, with the amendment that the State Board of Health act as a board of appeal in cases of dispute, and I accordingly again recommend its passage.

Legislative Plans for 1912.

At the special meeting at Barre several suggestions for the improvement of agriculture were brought forward, and, after discussion, referred to the executive committee, with instructions to consider the matter of appropriations for new lines of work and increased appropriations for the work of the Board and the agricultural societies, draft bills for the same, and report at the annual meeting of the Board. The executive committee met as instructed and drafted three bills, which they will present for your consideration.

1. A bill to provide for an increase of $200 in the bounty received by the agricultural societies, to be used for premiums and gratuities for farm crops, fruits and vegetables grown by children and youths.

2. A bill to provide for the appropriation of $5,000 annually, to be used for the encouragement of agriculture by holding special shows, either by the Board or other organizations, in demonstrations, agents, literature and otherwise.

3. A bill, in accordance with the vote of the Board at the summer meeting at Concord, to appropriate $25,000 annually for the encouragement of dairying, by offering prizes for the best kept barns, lowest bacteria count in milk, best quality of milk, for holding demonstrations, for agents, literature and otherwise for the encouragement of dairying.

The last-named bill is drawn for the special purpose of trying, in a practical manner, to bring about the production of clean milk by encouraging the dairyman in its production rather than by discouraging him in the production of all milk. Based on the belief that education and encouragement will do more than unfriendly inspection, it is sound in principle and should be of great value to both producers and consumers. The first two bills are self-explanatory and designed for the general encouragement of agriculture. That to increase the bounty received by the agricultural societies looks to the upbuilding of agriculture by interesting children and young people in its processes, and goes to the foundation of the question, "How shall we keep our boys on the farm?" These propositions have my hearty approval, and I recommend their passage by the Legislature.

Other bills for the improvement of agriculture have been drafted by your secretary and will be called to your attention under the proper headings.

Work of the Office.

The work of the office has proceeded in a very satisfactory manner during the year, but new work has come upon us to such an extent that, in spite of a larger regular office force, much of the special work which it was hoped to accomplish during the year has been obliged to go over into the future. Much has been done in bringing the library into a systematic condition, but the main work of cataloguing and numbering still remains to be done. The librarian has arranged a system whereby all matter received is tabulated and a record kept, so that it will be impossible for the library to again fall into the

condition in which he found it. All of the matter which was out of place on our shelves has been disposed of, either by sending to the Massachusetts Agricultural College, the State Library or the public document room, and we now have a compact working agricultural library. The correspondence of the year is the largest of any year in the history of the Board; more documents have been printed and distributed, and various new lines of work have been taken up and developed, so that the year has been an exceedingly busy one. Miss Grace C. Hall of Somerville was provisionally appointed assistant librarian on November 24, after having assisted us throughout the greater part of the year, under authority from the Civil Service Commission, there being no one on the list with the necessary qualifications for the position. The assistant librarian, in addition to her duties in connection with the library, is engaged in general office work, in stenography, typewriting and multigraphing. This work constantly increases and tends more and more to encroach upon the library work. With present plans and tendencies it is only a question of a short time when more help will be needed in the office and another increase in the appropriation for extra clerical assistance necessary.

This year, for the first time, our appropriation for incidental and contingent expenses in the office proved insufficient to cover the necessary items, and bills had to be carried over into the next fiscal year. This was the more remarkable as nothing was expended for binding pamphlets and reports during the year, an expense always borne from this appropriation. There is much binding that should be done if the library is to be kept up to the proper standard of usefulness, and there is no likelihood that the amount required for stamps, supplies, etc., will decrease. I have, therefore, in my estimates for the year asked that the appropriation be increased from $1,100 to $1,500 per annum, and would recommend that the Board instruct its committee on legislation to appear before the Legislature and urge the necessity for this increase.

A matter has arisen recently that threatens to seriously cripple the work of the Board, namely, the application of the chief of the Cattle Bureau of the State Board of Agriculture for more space, and the suggestion of the Sergeant-at-Arms that the

room now used as the private office of the Board and its secretary be taken for this purpose. This request was apparently granted, and the suggestion approved by the Governor's Council, but it has developed that their action was not definite and the matter is still in abeyance. Should this room be taken from us we will be left without a room for committee meetings, the secretary will be obliged to discuss all business, no matter what its nature, in the hearing of any one who may be in the office, Room 136 will be unduly crowded and the work of the Board greatly hampered. This proposition came upon us without warning. The visit of inspection to the office came at a time while the winter meeting, at Barre, was in progress, and through lack of explanation the rights of the Board were, perhaps, not sufficiently considered. As the force regularly at work in this office is in excess of that in the office of the chief of the Cattle Bureau of the State Board of Agriculture, and as his receiving the room now used as our private office, in addition to his present quarters, would give him more floor space than would be left to the Board, and also a private office, while the Board would have no place usable for that purpose, the injustice of the proposal is evident. I recommend that the matter be referred to the executive committee, with power to act.

Wild Deer.

The great damage done to agriculture by wild deer continues in about the same measure as in the past, their greatest menace being to young orchards, which some farmers find it impossible to bring into bearing age because of these creatures. They are also very troublesome in nurseries and market gardens in some sections, while the damage done by them to the regular farm crops and farmers' gardens is of great importance. The tendency of the selectmen and arbitrators who fix the damage done by deer is to place it too low, especially when fruit trees are in question. Therefore it would be desirable if these creatures could be entirely eliminated. This seems impossible, and the present law, allowing the farmer to shoot them, when doing damage to his crops, with any weapon, and giving a short open season, with the shotgun, in the five western counties, is fairly satisfactory. Repeal or change will probably be sought, on

grounds of sentiment, but should not prevail in the face of the manifest interest of the farmer in the matter. The Commission on Fisheries and Game gives the number of deer killed during 1910, doing damage in crops, as 327; during the open season, 1,281; total, 1,608. In 1911 the numbers were, doing damage in crops, 230; during the open season, 1,269; total, 1,499; or 109 less than in 1910. This shows that the number of deer in the State is probably not increasing, a gain to agriculture. I would recommend that the Board instruct its secretary and committee on legislation to oppose any attempt to repeal the present law in relation to wild deer, or to amend the said law along lines that would afford greater protection to these animals.

Changes in the Board.

The changes in the membership of the Board during the year came about entirely through the expiration of the terms of various members. Members retiring because of expiration of terms of service are: Charles E. Ward, after nearly four years of service; J. J. Mason of the Amesbury and Salisbury Agricultural and Horticultural Society, after twelve years of service; Frank P. Newkirk of the Hampshire, Franklin and Hampden Agricultural Society, after three years of service, but appointed by the Governor in place of Mr. Ward; Henry A. Turner of the Hingham Agricultural and Horticultural Society, after three years of service representing that society; L. J. Northup of the Hoosac Valley Agricultural Society, after three years of service; N. B. Turner of the Housatonic Agricultural Society, after three years of service; and John S. Appleton of the Nantucket Agricultural Society, after three years of service.

Meetings of the Board.

The Board held its annual summer field meeting at Concord on July 25, 1911. A lecture on asparagus growing, and an explanation of the experiments on asparagus at the asparagus branch of the Massachusetts Agricultural Experiment Station, was given by Mr. Charles J. Prescott, while Dr. H. J. Wheeler, director of the Rhode Island Agricultural Experiment Station, gave an exceedingly valuable and interesting paper on alfalfa growing. The attendance was good despite the extreme heat.

The public winter meeting of the Board was held at Barre, with the Worcester County West Agricultural Society, on December 5, 6 and 7. The program was an unusually fine one and the lectures and discussions of much interest and value. The lectures, with the more valuable parts of the discussions, are printed in this volume. The agricultural society and the citizens of Barre gave an informal reception to the Board and its guests, which was much enjoyed.

The annual business meeting of the Board was held at Boston on January 10 and 11. Special business meetings were held at Concord and Barre, in connection with the summer and winter meetings, and at Boston on May 3. At the latter meeting the by-laws of the Board were thoroughly revised, especially as to the committees of the Board.

Agricultural Societies.

The fairs of these societies were certainly successful from an artistic and educational standpoint. These exhibitions are growing better each year and are well worthy of the support they receive from the State and the interest they create in those who attend them. A feature or department of growing importance is that of exhibits by children and youths. Many societies are paying special attention to this line of work, and it is with a view to encourage them and others that the Board introduces the bill to increase the bounty for that purpose. In a financial way a number of the societies were handicapped by unfavorable weather, but most of them made a little money during the year. The following figures may be of interest, as illustrative of the standing and work of the societies.

Total amount originally raised by contribution,	$151,413 24
Total assets, 1911,	1,232,871 86
Amount paid out for premiums and gratuities, 1911, not including purses for trotting,	38,375 29
Total membership,	23,607
Number of persons receiving premiums and gratuities,	5,431

The societies responded generously to the request of the Board for assistance for the New England Fruit Show, and their contributions were once more of material assistance. I would

recommend that the Board make the same request for assistance for the New England Corn Exposition, if it shall hold an exhibition during the current year.

Farmers' Institutes.

The institute work has been as successful as usual during the year. One hundred and thirty-eight meetings have been held, with 192 sessions. All the societies held 3 or more meetings, except the Hoosac Valley Agricultural Society, which was excused from holding more than 2. Ten societies held 4 or more meetings, and 21 institutes were held with organizations other than agricultural societies. The attendance for the year was very good, averaging 126, as against 110 last year, 137 in 1909, 111 in 1908, 118 in 1907, 127 in 1906, 125 in 1905, and figures ranging from 94 in 1899 to 109 in 1904 for previous years.

The list of speakers was carefully revised by the committee on institutes and public meetings, and we have as strong a list of speakers as is available for any State in the country. No circuits have been arranged for the coming winter, but Dr. Geo. M. Twitchell, of Auburn, Me., will be in Boston for a period of about six weeks, and will be available at any time during that period. Your secretary attended the annual meeting of the American Association of Farmers' Institute Workers, at Columbus, O., early in November, the same being an interesting and profitable session.

The appropriation for the "dissemination of useful information in agriculture" was increased $1,000 in 1910, and this increase proved barely sufficient to meet current expenses, the appropriation being entirely exhausted. Much beside institute work is paid for from this appropriation, including bulletins, crop reports, nature leaflets, etc. These are continually being exhausted and new editions must be printed, so that the work increases more rapidly than the appropriation. I have included an increase of $1,000 for this purpose in my estimates for the year. It will not be necessary to present a bill to the Legislature, but I recommend that the Board instruct its committee on legislation to appear before the Legislature and urge the necessity of this increase.

Apiary Inspection.

The office of State Inspector of Apiaries was created in 1910, with a trial appropriation, and the office and work made permanent by the Legislature of 1911, with an annual appropriation of $2,000. The work has been carried on faithfully and earnestly during the year, with excellent results. The importance of this question to the horticulturist and vine grower is just beginning to be recognized, and many more people now understand the importance of bees and the necessity for their preservation in the community than was the case a few years ago. The work this year has been pushed in the centers of bee keeping and the surrounding territory and has been most successful. It is hoped to cover the State before the close of another year, and in any event the territory left uninspected at the close of 1912 will be of comparatively little importance from the beekeeping standpoint.

Nursery Inspection.

The work of nursery inspection has reached a point where something definite and permanent must be done if this great industry, with an annual turnover of $2,000,000, is to be saved to the Commonwealth. The Legislature of 1911 recognized this to a certain degree by appropriating $10,000 additional for the work by a special resolve, increasing the powers of the State Nursery Inspector. This sum, with the regular appropriation of $2,000, was just sufficient to get through the work of the year, and with the work on an annual basis would be inadequate. Further, the additional powers conferred upon the Nursery Inspector in this resolve should be made permanent if the work is to be carried on satisfactorily. The spread and prevalence of the gypsy and brown-tail moths makes it necessary to make an examination in the fall as well as in the spring, when the stock is inspected for the San José scale, and requires a large force of trained men. These are secured from the gypsy-moth force of the United States Department of Agriculture. Any failure to make this inspection as thorough as possible would result in the exclusion of our nursery products from the States that are now our most valuable customers. I recommend that

the Board present a bill to the Legislature enacting a new nursery-inspection law, which will be more generally satisfactory, and putting the work on a permanent basis, with an annual appropriation of $15,000.

Dairy Bureau.

The work of the Dairy Bureau has been carried on along the usual lines and with the usual success. The inspection and detective work of the Bureau have been characterized by firmness, justice and energy, so that the usual high standard of number of cases in court, convictions obtained and fines imposed has been fully maintained. The details of the work are given in the annual report of its general agent.

Cattle Bureau.

The work of the Cattle Bureau is so far independent that comment on it in this report is not proper. This work should be under the control and direction of this Board. It falls naturally under the province of the Board, and should never have been established on an independent basis, and the time has come when the mistake of the past should be rectified. This is no reflection on the chief of the Cattle Bureau or his methods, but a simple statement of what should be done to simplify and co-ordinate the work regarding agriculture carried on by the State. I would recommend that the Board present to the Legislature a bill placing the work of the Cattle Bureau under its direction and control.

State Forester.

The State Forester will report to you verbally, and his formal report will be printed in "Agriculture of Massachusetts" for 1911. The year has been a trying one in many ways for the State Forester, but he has come through it with his prestige undiminished and his usefulness unimpaired. I have nothing but good words to say of his work and that of his assistants, and feel it to be worthy of the hearty sympathy and co-operation of the Board.

State Ornithologist.

The State Ornithologist has been one of the busiest members of our force. There is hardly an hour of the day when he has not some caller interested in birds and their protection. His main activity has been centered on the history of game birds, shore birds and wild fowl, which he is preparing and which will be issued within a short time. His plans were well in hand to have the report out before the close of the fiscal year, and we hope that it will shortly be available for distribution. It will equal in importance and interest his earlier work on "Useful Birds and their Protection." When the importance and value of these two books is considered, the wisdom of the legislation establishing the office of State Ornithologist is thoroughly vindicated. The time has come when something must be done if the present incumbent is to be retained in Massachusetts. Other States and the United States government are reaching out for him, with attractive offers, and his salary should be increased to a living wage, so that he may be kept here and the credit of his work reaped by the Commonwealth of Massachusetts. I would recommend that the Board present a bill to the Legislature increasing the salary of the State Ornithologist to $2,000 per annum.

Massachusetts Agricultural College.

The college was unusually successful in the matter of appropriations during the session of 1911, and the work of development has proceeded without check. Continued generous support is deserved by the institution, which is growing in numbers and usefulness with every year, but if it is felt that everything asked cannot be given I would suggest that curtailment should not come along the lines of strictly collegiate effort. The college must be maintained as a college and will find its best development and greatest usefulness along collegiate lines.

The New England Fruit Show.

The second show of this organization was an even greater success than that of 1909. The Board assisted the show by furnishing an expert apple packer from Oregon to demonstrate the best methods of box packing to those interested, and the

agricultural societies assisted by generous cash contributions. The State exhibits were an especially attractive feature, and the plate collections, barrels and boxes of fruit shown were of a high order of excellence. The public interest was greater than two years ago, showing that the New England apple is making its way into favor with rapid strides, and that the apple growers, as a class, are extremely wide awake and up to date in their methods. The difficulty of financing such shows as this and the New England Corn Exposition would be largely overcome if the appropriation asked for this line of work, by vote of the executive committee, should be granted.

Massachusetts Corn Show.

This show was held at Springfield in November, and was an excellent one, considering the unfavorable season and comparatively small prize list. The first factor was probably not of as much importance as might be supposed, as those growers who exhibit at corn shows undoubtedly had their crops in such condition that they were harvested before the frosts of mid-September.

New England Corn Exposition of 1912.

This organization proposes to repeat the show held at Worcester in 1910 by an exhibition at Horticultural Hall, Boston, the coming winter. The interest in corn growing continues unabated, and we can well look for a better show than the first one held. This Board offers its hearty support and co-operation, especially valuable should the bill previously referred to become a law. If the agricultural societies continue to assist by their contributions the success of the show would seem to be assured.

American Land and Irrigation Exposition.

This exposition was held in Madison Square Garden early in November, being promoted largely by the railroads of the country for the display of agricultural products and the advertising of the agricultural resources of the sections through which they passed. The New England roads bought space for a New England exhibit and called upon the agricultural departments of

the various States to provide such an exhibit. Acting on recommendation from your secretary, Massachusetts appropriated $1,000 for her share in the exhibit. The other New England States promised assistance, and it was thought that the project would be amply financed. The burden was finally borne in the main by this State. Vermont did all that she promised, contributing between $250 and $300, and furnishing an excellent exhibit of maple sugar. Rhode Island contributed $50 to the general expenses. Maine contributed $75, and the Maine Central Railroad sent on a few boxes of seed potatoes. Connecticut furnished an exhibit of tobacco and paid the freight and cartage charges on the same. New Hampshire had no share in the exhibit. Your secretary's expenses for travel and necessary expenses were paid from the appropriation for that purpose, and $1,016.98 was expended in the preparation and showing of the exhibit, the slight overdraft being allowed by the Auditor. It will be seen, therefore, that Massachusetts' share in the exhibition was considerably in excess of that of all the other New England States combined.

A great deal of labor was involved in preparing the exhibit, shipping to New York, setting up and attendance, and more of care and planning. The result was very gratifying, the general feeling being that New England had far eclipsed the west in her showing of agricultural products. The backbone of the exhibit was composed of New England apples, the best fruit from the New England Fruit Show being sent to New York. The 50 boxes of McIntosh Reds purchased from Mr. A. A. Marshall of Fitchburg, Mass., were generally conceded to be the finest apples in the garden, and much regret was expressed that they had not been entered for the sweepstakes prize of $500, which they would probably have won if entered in the name of the owner. This was flanked on one hand by the tobacco exhibit from Connecticut and the maple-sugar exhibit from Vermont. The latter was particularly ingenious and pleasing. On the other side was an exhibit of vegetables furnished by the Boston Market Gardeners' Association, which was held by competent judges to be the finest exhibit of these products ever shown anywhere. Other articles shown were corn, cranberries and seed potatoes. Ross Bros. of Worcester

were awarded a special ribbon for the best exhibit of Flint corn. Some of the exhibitors from other sections spent as much as $40,000 on their exhibits, and New York had over $12,000 available, but if the crowds around the New England booth and the expressions of satisfaction heard were any indication, the general feeling was that our exhibit was the best of all. The result was well worth the effort involved, as the exposition was designed primarily to interest New York capital in western agricultural opportunities, and those who visited the garden were shown that their best opportunity lay nearer at home, namely, among the New England hills. Mr. P. M. Harwood had charge of the exhibit and labored enthusiastically and effectively to make it a success. Acknowledgments are due to the secretaries and commissioners of agriculture of the States that assisted; to Ross Bros. of Worcester; to H. F. Hall, president of the Boston Market Gardeners' Association; to G. A. Drew, manager of Conyers farm, Greenwich, Conn.; to Fred A. Smith, manager of Turner Hill farm, Ipswich, Mass., and to many others who furnished fruit and vegetables and assisted in other ways.

The exposition is to be repeated in New York the coming fall, with a two weeks' show. Much of the ground gained by the favorable advertisement which New England received would be lost if she is unrepresented there, and I recommend that the Board present a bill to the Legislature calling for an appropriation of $3,000, to allow Massachusetts and her agriculture to be properly represented. The increase is necessary, as the railroads do not propose to again purchase space in the hall, and because of the uncertainty as to the other States rendering any efficient or substantial aid to the project.

Exhibit of the Work of the Board.

At the request of the Massachusetts Agricultural College an excellent exhibit of the work of the Board was prepared for the Rural Social Service Exhibit at the College in connection with the annual conference of Rural Social Workers. It consists of cards bearing short statements of the various lines of work carried on by the Board, grouped under the head of "activities;" of cards showing the literature issued by the Board, with samples of the same attached, and statements of the terms on

which they are distributed, under the head of "literature;" and a collection of crop-production charts, showing the importance of the various crops of the farm, garden and orchard, and of agricultural products, from the State census of Massachusetts for 1905, the same being indicated on maps by the shading of the towns within certain limits of production with various colored crayons. The whole exhibit was most interesting and instructive. It was afterwards sent to the fairs of the Worcester East, Franklin County, Worcester County West and Franklin, Hampshire and Hampden agricultural societies. It suffered considerably in the process and is not now in the best of condition, but will be put in order during the winter and will again be available for similar purposes during 1912.

Farm Catalogue.

At the last session of the Legislature the Board asked for an appropriation of $3,000 to carry on the work of collecting and circulating information in regard to farms for sale, and the agricultural resources, advantages and opportunities of Massachusetts. The plan was to issue a reprint of the catalogue put out in 1910 and to collect information for a new edition and publish the same as soon as possible. The Legislature provided an appropriation for the former purpose only, so that the work of gathering new material could not be undertaken. There has been a large demand for the catalogue during the year, and it was reprinted in an edition of 10,000 copies. The greater part of these have been distributed, but enough copies remain to fill orders for some time to come. The information contained in the catalogue, so far as the list of farms is concerned, is rather out of date, and if the work is to be continued it should be by gathering a new list of farms to be advertised, and thoroughly rewriting and arranging the information contained in the balance of the catalogue. With the present demand for New England farm property this catalogue has a valuable purpose to serve and should be continued for two years at least. I recommend that the Board present a bill to the Legislature providing for the appropriation of $3,000 for the purpose of collecting, printing and distributing this information.

The Encouragement of Orcharding.

The appropriation of $500 for this purpose was expended along different lines from those of the previous year, and the results are believed to have been even greater for the apple growers of the Commonwealth. The greater part of the money available was devoted to the services and expenses of an expert apple packer, Mr. John B. Castner, of Hood River, Ore., who came here primarily to give demonstrations of the best methods of box packing at the New England Fruit Show. Mr. Castner is admitted to be the best man for the purpose, having packed prize-winning exhibits for the great apple shows of the country, and being well able to explain the processes of packing and the reasons for them. He came on several weeks in advance of the Fruit Show and remained over for some little time after its close, giving instructions in apple packing to various growers, who paid for his services and expenses while with them, arranging and setting up the apple exhibit at the American Land and Irrigation Exposition, and acting as judge at the exhibition of the Maine State Pomological Association. As packing is the only point where the best western fruit has any advantage over the best eastern fruit, and as we must meet western competition at this point in order to avail ourselves of our natural advantages of situation and flavor of fruit to the fullest extent, the importance of this step taken by the Board becomes at once apparent. That the practical results achieved were all that was expected was apparent from the interest taken in Mr. Castner's work and the immediate improvement in packing shown by many of our best growers. One hundred and seventy-five dollars of the appropriation was used for prizes for Massachusetts fruit at the New England Fruit Show, and $15.35 contributed to the expense of preparing the Massachusetts exhibit for the show.

Poultry Premium Bounty.

The poultry premium bounty was distributed among the incorporated poultry associations applying for such bounty in accordance with the rules established by the Board for the

same. The full amount was paid out for the first time since the appropriation has been available, and we were obliged to prorate the amounts paid according to the amounts expended by the various associations for the purposes recognized by the rules of the Board. The organizations receiving bounty and the amounts paid follow: —

Dalton Poultry, Pigeon and Pet Stock Association,	$85 84
Essex County Poultry Association,	103 40
Holyoke Poultry and Pet Stock Association,	189 67
Milford Poultry Association,	134 01
Northern Berkshire Poultry Association,	133 12
Springfield Poultry Club,	204 59
Worcester Poultry Association,	149 37

Bulletins of Massachusetts Agriculture.

The demand for these publications continued unabated during the year, and in fact increased to a considerable degree. A new bulletin, Bulletin No. 5, on vegetable growing, was issued in November, in an edition of 4,000 copies. It treats of practically all the garden crops of any importance, also of market gardening as a business, the home garden and mushroom growing. It is illustrated by a number of cuts, showing choice kinds of vegetables, implements and methods of storage. The supply of Bulletin No. 2, on orcharding, is exhausted. It will be revised and reprinted as soon as possible, several of the older papers being dropped out and new material, obtained at the winter meeting at Barre, substituted. It will be republished under the title "Apple Growing," as being more truly descriptive than that of "Orcharding." Bulletin No. 1, on poultry culture, is running very low in supply, and the edition of No. 4, on small fruits and berries, will be exhausted before the close of the year. Bulletins should be issued on dairying, animal husbandry and bee keeping. These bulletins form the most valuable of the many kinds of literature which we distribute, and the editions should be maintained, strengthened, and new bulletins printed. This forms the most pressing cause and best argument for an increased appropriation for "dissemination."

Crop Reports.

The monthly crop reports were issued from May to October as usual. New features during the year were agricultural statistics, from the advance sheets of the United States Census report; statements in regard to the summer field meeting of the Board and the exhibit of the work of the Board; and a list of places and dates of fairs. The special articles included in the various issues, in order of appearance, from May to October, were: "The growing and marketing of squashes, melons and cucumbers," by Henry M. Howard; "Cabbage and cauliflower as market-garden and farm crops," adaptation by Howard N. Legate from Farmers' Bulletin on "Cabbage," by L. C. Corbett; "The more important root crops of the market garden," by H. F. Tompson; "Beans, corn, tomatoes, lettuce and spinach as market-garden crops," by Henry M. Howard; "Some of the essentials of beekeeping," by Dr. Burton N. Gates; and "The cultivation of mushrooms," adaptation by Howard N. Legate from Farmers' Bulletin on "The cultivation of mushrooms," by Prof. B. M. Duggar. The editions were 6,500 for May, 6,700 for June and July, 6,900 for August, 7,200 for September, and 7,300 for October. The largest previous edition was 6,500 for August, 1910. Copies are on hand for distribution of the September and October numbers, but the editions for the other months are exhausted. This is of less importance than usual as the special articles contained in them are included in Bulletin No. 5, on "Vegetable growing."

Publications.

The following publications were issued by this office in 1911, and, except those indicated, may be obtained on application: —

	Pages.	Number.
Agriculture of Massachusetts, 1910,	728[1]	15,000
Crop Report No. 1,[2]	40	6,500
Crop Report No. 2,[2]	44	6,700
Crop Report No. 3,[2]	40	6,700
Crop Report No. 4,[2]	36	6,900
Crop Report No. 5,	48	7,200
Crop Report No. 6,	44	7,300
Massachusetts Agriculture, Bulletin No. 5,	142	4,000
Massachusetts: her Agricultural Resources, Advantages and Opportunities, with a List of Farms for Sale (second edition, revised).	170	10,000
Apiary Inspection, Bulletin No. 2, First Annual Report of State Inspector of Apiaries.	20	5,000
Farmer's Institute Pamphlet,	16	1,000
Nature Leaflet No. 1 (reprint),	4	2,000
Nature Leaflet No. 3 (reprint),	4	2,000
Nature Leaflet No. 4 (reprint),	4	2,000
Nature Leaflet No. 6 (reprint),	4	2,000
Nature Leaflet No. 7 (reprint),	4	2,000
Nature Leaflet No. 9 (reprint),	4	2,000
Nature Leaflet No. 10 (reprint),	4	2,000
Nature Leaflet No. 11 (reprint),	4	2,000
Nature Leaflet No. 12 (reprint),	8	2,500
Nature Leaflet No. 13 (reprint),	4	2,000
Nature Leaflet No. 16 (reprint),	8	2,500
Nature Leaflet No. 17 (reprint),	8	2,500
Nature Leaflet No. 18 (reprint),	4	2,000
Nature Leaflet No. 19 (reprint),	8	2,000
Nature Leaflet No. 20 (reprint),	8	2,000
Nature Leaflet No 21 (reprint),	4	2,000
Nature Leaflet No. 26 (reprint),	4	2,500
Nature Leaflet No. 27 (reprint),	4	2,500
Nature Leaflet No. 29 (reprint),	8	2,500
Nature Leaflet No. 30 (reprint),	8	2,500
Nature Leaflet No. 31 (reprint),	8	2,500
Nature Leaflet No. 32 (reprint),	8	2,500
Nature Leaflet No. 33 (reprint),	8	3,000
Nature Leaflet No. 34 (reprint),	12	2,500
Nature Leaflet No. 39 (reprint),	8	2,500
Nature Leaflet No. 40 (reprint),	8	2,500

[1] Including twenty-third annual report of the Massachusetts Agricultural Experiment Station, 356 pages.

[2] Edition exhausted.

	Pages.	Number.
Nature Leaflet No. 42 (reprint),	8	2,500
Nature Leaflet No. 43 (reprint),	4	2,500
Annual Report of State Nursery Inspector,[1]	8	500
Annual Report of State Ornithologist,[1]	36	3,000
Annual Report of Chief of Cattle Bureau,[1]	28	500
Alfalfa as a Crop in Massachusetts,[1]	10	500
Growing and Marketing Asparagus,[1]	10	500
Celery Growing, Storing and Marketing,[1]	10	500
Corn Growing in New England,[1]	14	1,000
The Production of Market Milk,[1]	18	1,000
New England Pastures,[1]	10	500

Legislative Appropriations.

Objects for which Appropriated.	1911.	
	Appropriated.	Used.
Traveling and necessary expenses of the Board,	$1,300 00	$1,183 83
Salaries of secretary and clerks,	6,200 00	6,200 00
Traveling and necessary expenses of the secretary,	500 00	361 04
Lectures before the Board and extra clerical assistance,	1,600 00	1,214 65
Incidental and contingent expenses, including printing extracts from the trespass laws.	1,100 00	1,120 45[2]
Dissemination of useful information in agriculture,	5,000 00	5,006 11[2]
Printing 15,000 copies "Agriculture of Massachusetts,"	6,000 00	5,989 45
Reprinting 10,000 copies farm catalogue,	1,500 00	1,500 00
Bounties to agricultural societies,	18,000 00	18,094 37[3]
Poultry premium bounties,	1,000 00	1,000 00
Encouragement of orcharding,	500 00	500 00
Exhibit at American Land and Irrigation Exposition,	1,000 00	1,016 98[2]
State Apiary inspection,	1,499 96[4]	2,141 91
State Nursery inspection,	12,000 00[5]	10,031 36
State Ornithologist, salary and expenses,	1,000 00	958 98
Special report on game birds,	3,915 00[6]	430 00
Work of Dairy Bureau, including salaries,	9,800 00	9,775 55
	$71,914 96	$66,524 68

[1] Excerpts from "Agriculture of Massachusetts," 1910, issued in pamphlet form.
[2] Overdraft paid from appropriation for "small items."
[3] Overdraft paid from appropriation for "extraordinary expenses."
[4] Unexpended balance of $99.96, and appropriation of $1,400 instead of $2,000 as provided by law.
[5] Regular annual appropriation of $2,000 and special appropriation of $10,000.
[6] Unexpended balance.

Extracts from Trespass Laws.

The distribution of printed extracts from the trespass laws has been continued during the year in accordance with the law relating thereto. Each post office in the State was furnished with a copy on paper for posting. The demand continues about as in former years.

Seed Corn Distribution.

The distribution of seed corn of superior strains, recommended by the secretary in his last annual report and approved by the Board, was carried out as planned. Several ears were distributed, personally and through the mails, to over 200 applicants. The effect of the work was to call attention to the necessity for improvement in corn growing, but the results in corn returned, reports of methods used and results obtained, and yields reported were not favorable enough to make it seem advisable to repeat the experiment.

Respectfully submitted,

J. LEWIS ELLSWORTH,
Secretary.

Jan. 9, 1912.

Summary of Crop Conditions, 1911.

May opened cold and dry, and continued dry, but warm weather from the middle of the month on brought vegetation forward so that it was fully normal at the close. Early crops were, however, slow in germination. Grass started late, made slow growth until the hot weather came, and was then checked by drought. Feed in pastures was generally short. Fall seeding winterkilled more than usual. The fruit bloom was generally unusually heavy, with no frosts to do damage. Insects were rather more plentiful than usual, with cutworms very prevalent and doing much damage in eastern sections. Gypsy and brown-tail moths continue to extend their territory, and the San José scale is more prevalent than ever. Planting was delayed by the cold and dry weather, and in many sections was behind the normal. Germination of seeds was retarded by drought. Farm help appeared to be rather more plentiful than usual, with wages moving upward, with $25 per month with board the average wage.

With the reports for June an unusual amount of damage from cutworms was apparent, but their ravages were then practically over for the season. Other insects were a little more troublesome than usual. The acreage of field corn was not increased to the degree indicated by returns for May, owing to failure to germinate, but was greater than for several years. The crop was not in the best condition, owing to cool weather. Haying had hardly begun in any section, and a light crop was in prospect, despite the improvement following the rains. Clover germinated poorly and winterkilled badly. The acreage of early potatoes was decidedly decreased, and the crop was somewhat backward. Early market-garden crops suffered from drought, cold weather and cutworms, and were generally light in yield and high in price. The

supply of dairy products was fully up to the demand, with prices for milk lower than last year in the metropolitan district. Where farmers had cows for sale the prices were reported as low, while in eastern sections they were unanimously said to be higher than ever before. Pasturage suffered from drought in May, but responded to the rains, and was quite good at the close of the month. Strawberries were a light crop, with good prices. Currants were light, but raspberries and blackberries promised well. Apples indicated a fair crop. Peaches promised a larger crop than for some years. Cherries were generally an excellent crop. Spraying is receiving more attention each year.

In July there were few complaints of insect damage. The hot weather brought corn forward rapidly, and in western sections it was well up to the average, but suffered from drought in central and eastern sections. The hay crop was very light, of good quality, but with little clover. The prospect for the second crop was poor, owing to drought and hot weather. Forage crops germinated poorly and in some cases were not sown to as great an extent as usual, owing to the dry and baked condition of the ground. Market-garden crops suffered severely from drought, and were short in almost all cases, with prices correspondingly high; later crops looked well, though needing rain. Early potatoes were a very light crop, while the later ones looked well. There was an unusually heavy crop of fruit, apples especially. Pears promised fairly well, also plums. Peaches seemed a better crop than usual. Grapes promised a good yield. Cranberries felt the effects of drought, and promised less than an average crop. Pastures were in fairly good condition in western sections, not so good in Worcester County and very poor in eastern sections. Rye was a fair crop and oats a three-fourths crop. Oats did fairly well as a forage crop. Barley is not grown except as a late forage crop. Thirty-five of 117 correspondents reported some orchard planting, ranging from 2 acres to 2,500 trees.

Corn came forward very rapidly with the warm weather and light showers of August, and promised a full normal crop. The rowen crop promised to be very light in all sections, with practically none in eastern districts, owing to severe

drought and general failure of clover to germinate. Potatoes showed a luxuriant growth of vines, but were reported as not set well and few in a hill and small. Blight was frequently reported, with a few reports of rot. The acreage of tobacco shows a slight decrease, but the crop generally promised well, with good prices. A light crop of apples was indicated in most sections. Fruit was reported as unusually fair, with much less insect injury than usual, owing to increased spraying. Pears were generally a good crop, peaches much better than usual, grapes abundant and cranberries below the normal, with small berries. Pastures were generally in good condition in western sections, fair in the central part of the State, and much below the average in eastern sections. Oats were a light crop for grain, but more satisfactory for hay. Barley was backward at time of making returns. Celery was short and backward. Other late market-garden crops generally promised well. Midsummer market-garden crops were light yields, with good prices.

Heavy frosts on the 13th, 14th and 15th of September severely damaged the corn crop, many strains not having matured the ears and the stover being generally badly damaged. The feeding value of ensilage corn was much impaired. Rowen was a very short crop before the rains, and light at best and suffered much damage from rain while curing. Fall feed came along well, both in pastures and mowings. Considerably less than the usual amount of fall seeding was done, owing to dry weather in August and continued rains in September, but it germinated well and was in good condition. Onions were a very light crop in all sections, especially in the Connecticut valley, small in size, and with prices unusually high. Potatoes were a very light crop in almost all sections. Root crops were generally in good condition. Celery promised well, with some reports of decreased acreage. Other late market-garden crops generally promised well. Apples were a light crop, less than half a crop, of excellent quality where sprayed. Pears were generally abundant, peaches a heavier crop than usual, grapes a heavy crop and cranberries a light crop. The frosts destroyed all tender vegetation, except on Cape Cod, and the damage was less in Bristol and Plymouth

counties than elsewhere. More or less tobacco was caught unharvested. Considerable damage was reported in the market gardens of eastern sections.

The final report of the season, at the close of the month of October, showed that the corn crop was considerably below the normal in value, owing to damage by drought, frost and rains since harvest. The heavy frosts of the middle of September cut the crop short in almost all sections, but do not appear to have done as much damage to the grain as was then anticipated. For grain, the crop, judged from the returns of the correspondents, roughly averaged, was about three-fourths of a normal crop in value. The value of the stover seemed to have been diminished somewhat more, perhaps one-third off the normal. Ensilage corn suffered more from frost than that grown for grain, as but few had ensiled their corn when the frosts affected it. There were very few reports of root crops being above the average, and enough of their being below to warrant the conclusion that for the State as a whole they were slightly below the average. The heavy rains kept fall feed green and growing up to the time of making returns, and farm stock generally improved in condition during the month. Considerably less than the usual amount of fall seeding was done, owing to the dry condition of the ground at the usual time for seeding, and the continuous rains that followed the breaking of the drought. That put in was generally reported as having germinated well, with the rains, and to have come forward in fine style, being in good condition at the time of making reports.

Prices were generally rather higher than usual, owing to short crops. Potatoes brought particularly high prices, as did also some of the market-garden crops at times. Apples generally brought prices fully up to last year, and in some cases above, owing to the short crop and generally improved quality, due to better care and spraying. Prices for tobacco and onions were generally high. Seventy-seven correspondents consider prices to have been higher than usual, 37 average and 6 lower than usual.

Forty-four correspondents, rather a small number to unite on one leading crop, considered hay to have been among the

most profitable crops; 27, corn; 22, potatoes; 19, apples; 9, cabbage; 7, tobacco; 5, onions; 4, tomatoes; 4, cranberries; 4, strawberries; and 4, beets; while 78 correspondents, more than a majority, and an unusually large leading number, considered potatoes to have been among the least profitable crops; 12, hay; 11, corn; 10, apples; 6, squash; 6, onions; 4, oats; 4, strawberries; and 4, tomatoes.

The season was hardly regarded as a profitable one for our farmers, 52 correspondents speaking of it as not profitable; 2, as fairly profitable; 10, as not up to the average for profit; 8, as not very profitable; 7, as an average season for profit; and 41, as profitable. Crops were short, owing to drought and frost, and while prices were high in most instances the increase in price did not seem to counterbalance the short yields.

The heavy rains of October had a good effect on streams, springs and wells. In the western counties they were almost universally reported as having fully recovered from the effects of drought. The ground was generally reported to be full of water, and grass and vegetation to have recovered to a remarkable degree from the previous bad effect of the drought.

PUBLIC WINTER MEETING

OF THE

BOARD OF AGRICULTURE

AT

BARRE.

December 5, 6 and 7, 1911.

PUBLIC WINTER MEETING OF THE BOARD, AT BARRE.

The annual public winter meeting of the Board, for lectures and discussions, was held at the Town Hall, Barre, on Tuesday, Wednesday and Thursday, Dec. 5, 6 and 7, 1911. The attendance was good, being especially so on the second day, the lectures of a very high order, and the discussions the best and most helpful for some years.

The meeting was called to order at 10 A.M., on Tuesday by Secretary Ellsworth. Mr. John L. Smith of Barre presided, and introduced Mr. James A. Rice, former president of the Worcester County West Agricultural Society, who delivered the address of welcome.

ADDRESS OF WELCOME, BY JAMES A. RICE.

It is my privilege to offer to you the greetings of the Worcester County West Agricultural Society and the people of Barre, on this third visit of the State Board of Agriculture to our town. At the meeting held in this hall twenty-six years ago, your Board was greeted, on behalf of the town, by a gentleman well known to many of you, Mr. J. Henry Goddard, and on behalf of the society, by a gentleman whom I hope we may see at this meeting and who is well known to all of you, the Hon. Charles A. Gleason, at that time of New Braintree. I wish I were able to-day to offer you greetings in the same graceful manner as these gentlemen, but they are no less cordial and sincere, though not so well expressed.

Agriculture is still the most important industry of our town. We have suffered, as other New England towns have suffered, in that during the past fifty years much of the best manhood and womanhood of the community has gone to

build up other places. Many a farm that twenty-five years ago was the home of a thrifty family is now marked by partially ruined buildings, or perhaps by the cellar hole, the lilac bush, and in June by the red rose, which stays for so many years after the owner has gone. Still, a drive among our farms will show a prosperous people, and at no time have we farmers received so large a money return for our products.

"The cost of high living, not the high cost of living," to quote James J. Hill, is responsible for much of the unrest and migration from the farm, in the hope of finding something easier and better somewhere else. Free mail delivery, telephone service, installation of heating and water service, delivery of merchandise, use of automobiles, — all of which are looked upon as necessities by our farmers to-day, — would have appeared the height of luxury to any family twenty-five years ago. If we farmers would be more thankful for what we have and think less of what we would like to have it might be better for us. Compare the increased knowledge of practical agriculture, which will be shown in the addresses and discussions of this meeting, with those of 1872 and 1886. In our lament for the "good old times," — and our present day life would be better for some of the self-denial of that time, — let us stop, think and realize the advanced thought in practical agriculture. A glance at the programme and the names of the speakers shows that your secretary has "made good," and we members of the Worcester County West Agricultural Society and citizens of Barre offer you a hearty welcome and the freedom of our town.

The chairman then introduced Secretary Ellsworth, who made the following response, on behalf of the Board, to the address of welcome: —

RESPONSE FOR THE BOARD, BY SECRETARY ELLSWORTH.

First Vice-President Bursley, who was to have responded to the very pleasant words of welcome to which we have just listened, is unable to be with us at this opening session, and

it devolves upon me to fill the gap as best I may. We fully appreciate the kind words with which Mr. Rice has greeted us, and we appreciate further the spirit that is behind them, and the cordiality of the people of the agricultural society and the town which they so well reflect. The address was along the lines that I am always glad to hear, looking forward to better times, and appreciating the good things connected with the agriculture of the present day. When we received the invitation to hold this meeting in Barre I was very much gratified. Being a Barre boy myself, I was glad to have one of these public winter meetings held in this town while I was the secretary of the State Board of Agriculture. I remember very well, although it is a good many years ago now, when I went to the high school in this building, and the many things that happened in those days, and I find those boyhood recollections, as I believe is the case with almost all of us, to be among the most pleasant of my life. I remember the agriculture that was carried on here at that time, and it was quite different from that of to-day. In those days the farmers raised cattle for the market, made cheese from their milk, and raised various farm crops. They were a prosperous people and made money, although they did not handle anywhere near as much money as do the farmers of to-day; but their expenses were so much lighter that they had no need to take in so much to make a comfortable living and lay by something in the bank. To-day I do not believe that there is any better place in the world to practice agriculture than here in Worcester county, or, to be more specific, right here in Barre. Our farmers are prosperous to-day, and the failures are due, I believe, to the fact that we are in the transition stage, between the frugal practices and small operations of our fathers and the large expenditures, extensive operations, large out-go and large in-take which will mark the successful agriculture of the next few decades. When our people have accustomed themselves to the handling of money in the larger sums necessary to modern agriculture, I believe that there will be fewer failures, and that we shall hear less about the " high cost of living."

I feel that we have presented a programme this year that will be unusually instructive and interesting. It was prepared with great care to meet the needs of the agriculture of this section, and because this agriculture is typical to a large degree of that of the State, it will meet the needs of the progressive farmers of all sections. It is our effort to make these meetings instructive, and this year I feel sure that we have been unusually successful along educational lines.

Again I thank your spokesman for his kind words of welcome.

The Chairman. The United States is doing a great deal for agriculture, and we are especially fortunate in having one of its representatives here to tell us something of what is being done. I take pleasure in introducing to you Mr. Henry J. Wilder of the Bureau of Soils, United States Department of Agriculture, who will address us on "The influence of soil variation on crop production."

THE INFLUENCE OF SOIL VARIATION ON CROP PRODUCTION.

BY H. J. WILDER, BUREAU OF SOILS, UNITED STATES DEPARTMENT OF AGRICULTURE.

The influence of soil variation on crop production is best illustrated perhaps, by the development of special crops in different sections of the country. In many cases the highest development of such crops has taken place under a definite and restricted range of soil conditions. We are inclined to look at special crop districts already developed as examples of agricultural adaptation that were bound to appear in the natural course of events. We are also inclined to forget the many individuals who have fallen by the wayside in helping to develop such districts. Yet it is exceedingly doubtful if any section or locality in this country has earned a reputation for producing some crop well without having its course to that success marked by many failures of the individual farmer. There was a first man, for instance, to make some money in growing tobacco in the Connecticut valley. His neighbors followed him. The kinds of soil upon which they tried this crop were diverse, and the quality of the tobacco equally so. Hence the prices received yielded a profit or a loss, as the case might be. The use of commercial fertilizers was begun, and in the keen struggle to produce successfully this crop, which promised high profits when well grown, every kind of fertilizer offered for sale was tried. It is perhaps not stating the case too strongly to say that for a time it was felt that if just the right fertilizer could be secured we should have the magical key to more universal success and profit. Where the soil conditions and the care

given the crop were favorable the use of commercial fertilizers generally paid well enough to warrant their purchase and to establish a more or less rational system of selecting and applying them. Thus has the most profitable field practice with tobacco in the Connecticut valley been developed.

But some fields would not produce a grade of leaf that could be sold at a profit; and this occurred, too, where the same seed was used, and where the same conditions of fertilization and care were supplied. Such failures were unquestionably due to an unfavorable soil. I recall instances where men failed to produce crops profitably notwithstanding the fact that their endeavors were as vigorous and as intelligently applied as those of more successful neighbors. These men have been, in some cases at least, victims of the lack of soil adaptation to the crop they were trying to grow, and I fear that local judgment of their ability as farmers has not infrequently been uncharitable.

But a much more common loss has resulted from the trying out of fields whose adaptability to tobacco was guessed at by the individual farmer. One year's experience on a new field has often been sufficient to show its lack of adaptability to this crop, and the loss entailed not heavier than could be borne, but such trials have in the aggregate been very expensive, both for the individual and for the public. They have been of great advantage, however, to the individual farmer of to-day in giving him opportunity to avoid similar mistakes if he will avail himself of the experience of his own community.

The correlation of all these results and best crop practices found under a wide range of conditions can hardly be undertaken by the individual, as it involves problems at least of State and probably of National scope. In many cases careful experimentation is necessary before safe conclusions can be drawn, and it is the endeavor of the National Department of Agriculture, together with various State organizations, to solve as many as possible of these diverse farm problems. It is the province of the field work of the Bureau of Soils to solve one of the several important factors of crop growing, namely, how to select soils so that the different crops, and,

where possible, the different varieties of the same crop, may be grown with most profit. It is for this economic reason that the study of soil adaptation to crops is of so much importance.

In the Connecticut valley of Massachusetts and Connecticut the physical character of the soil not only determines what specific crops shall be grown on the different types, but the adaptability of those soil types to such special crops has in turn been the principal basis of land valuation there for the last half century. On my father's farm there were three principal types of soil. On the western third a sandy loam gave an excellent quality of wrapper leaf tobacco, and for this reason was bought at a price of $200 an acre, without buildings. It was not nearly as good for corn or grass as the medium brown loam on the eastern third of the farm, which was then valued at approximately $100 an acre, nor as good for grass as the heavy, dark, silt loam of the middle third, at about $75 an acre. Because of the better yields of corn obtained from the loam, my father, in his early experience there, reasoned that it should produce a good crop of tobacco also. Forced to sell the product for about one-half as much per pound as that grown on the sandy loam, though all methods of fertilization and care were the same, he was not long in drawing the conclusion that he needed no further experience in determining the adaptation to crops of that particular soil.

When onions became an important money crop in the Connecticut valley he learned that the best tobacco soil on the farm produced the best quality of onions also, but that the brown loam would give a larger yield through a succession of seasons, and that the quality was not enough poorer to be of material consequence. The surrounding locality soon reached the same conclusion, and then the price of that soil type went up. But the price of the dark, silt loam in the middle of the farm has remained nearly stationary, because it produced a thick, gummy leaf of tobacco and a poor grade of onion. For the latter crop this soil does not dry out early enough in the spring. Then, too, its tendency to form small clods which cause sore fingers during hand weeding is objectionable, and any rain at harvest time causes this

somewhat sticky soil to adhere to the bulbs, and render them less salable. The tops do not cure down as well in the fall on this heavy, silt loam, and this causes some inferior onions, especially if the season be wet and late. No doubt many of you have noted similar instances with this or other crops in your own farm experience without realizing that it might be a case of soil adaptation.

In the rapid development of tobacco growing in Florida and near-by States during recent years soil selection has been one of the most important factors; indeed, within that very considerable district possessing a suitable climate, soil selection has been of chiefest importance, and this phase of adaptation has been carried even to the point of breeding tobacco to suit local soil conditions. Deep sandy soils and light sandy loams yield the thin elastic leaf desired for cigar wrappers, while a similar surface soil, underlain by a dark red clay loam subsoil — the Orangeburg sandy loam — yields a thicker leaf of much heavier body, that is worthless for cigar wrappers but very desirable for cigar fillers. These two types of soil occur side by side, often on the same farm, at the same elevation, and so of course under the same climatic conditions.

Sugar cane in the Gulf States grown on the soil type with the red clay loam subsoil mentioned above yields a syrup that brings a lower price than that from another type associated with it, — the Norfolk sandy loam, — which has a more plastic subsoil of yellow color. With other conditions equal, the latter soil also yields more gallons of syrup per acre than the type with the red subsoil. This is undoubtedly due to the greater freedom with which the cane-root system can penetrate the subsoil, as the red subsoil is stiff enough in some cases to hinder root expansion, — a condition to which the sugar cane plant is sensitive.

Sea-island cotton took its name from being grown on islands along the coast of South Carolina. Its long, beautiful staple is now secured in northern Florida and other Gulf States when grown on deep, fine-textured, loamy sands similar to those of the sea islands which it made famous. But on the heavy soils, or even shallow, sandy loam surface soils

underlain by heavy clay loam, a common soil occurrence in that region, it does not succeed, and is replaced by the short-staple varieties.

In southwest Minnesota a shallow glacial valley some three miles wide divides the upland prairie, which extends for many miles in transverse direction. The irregular valley walls range in height from 15 to 30 feet, or in some cases a little more. The valley soil is a clay loam, richly charged with humus. It is suited to grass and other forage crops, but wheat runs heavily to straw, none of the grain grading above No. 2, while much of it is No. 3. Wheat from the gray clay loam to the west of the valley, where the growth of straw and the filling of the heads is well balanced, gives a high percentage of No. 1 grain. Grown on the brown loam east of the valley, the grade is about half No. 1 and half No. 2. These lands have been farmed only thirty to forty years, hence they have never been dressed to any appreciable extent with yard manure or commercial fertilizers. The superintendent of the elevator at the county seat where most of the grain is sold told me that he could tell on which of these three soil types a farmer unknown to him lived by the way his wheat graded. However this may be, the influence of the soil on the quality of the same varieties of grain is effectively shown by the money returns at the elevator.

The dark-colored valley soil referred to is of the same character as the famous corn soils of Iowa, and were the climatic conditions in Minnesota as suitable for the growth of corn, this type of soil would undoubtedly equal its prototype in Iowa for the production of that crop.

In southeast Michigan the profit from sugar beets grown for the factory follows closely the character of the soil upon which the beets are grown. Beets from light sandy soils have a high sugar content, with a high coefficient of purity, but the tonnage is relatively small. Moist, rich, clay loams yield a heavy tonnage, but the sugar content is low, and the coefficient of purity very unsatisfactory. The farmers' goal is to secure the highest possible tonnage consistent with a high sugar content of satisfactory purity. This combination is best found

there in a good, strong, sandy loam, underlain by a plastic light clay loam subsoil at a depth of 12 to 20 inches. Nearly as good is a deep, fine, sandy loam extending to a depth of 3 feet or more.

Without taking time for further illustration, the specific cases of soil adaptation to crops already described will be sufficient to show, perhaps, that many of our leading crops have reached their highest development on special types or conditions of soil.

It may be worth while to note here that our natural forest growth also indicates clearly that many varieties of trees succeed best on certain kinds of soil. The local name "black walnut land" is still used where that hardy tree grows to indicate a heavy type of soil. In southeast Michigan this is the Miami clay loam. The hickory thrives in the northeastern States on the heavier soils. Black walnut and hickory are both deep-rooted trees. In the same region "hemlock land" always indicates a sandy soil, and the hemlock is not a deep-rooted tree. In the orchard districts of West Virginia the leading peach growers will not tolerate "white oak" land, but a mixed growth of "rock oak and chestnut," about one-third of the former and two-thirds of the latter, indicates a soil which has been instrumental in making one of the most famous fruit districts in the world. The rock oak and chestnut growth indicates a soil somewhat stronger than that of chestnut alone, as a better supply of moisture is maintained; when newly cleared it is more productive, and even on old ground better results are secured from fertilization. The subsoil is finer textured, that is, more clayey, than the chestnut subsoil, but still is not so heavy as the white oak soil. Yet on the latter some varieties of apples thrive. Carrying a step further the matter of soil adaptation to the different varieties of oak, it is a matter of common observation that poor and thin soils often support only the dwarfish black jack oak and the post oak.

Shreve has found in his forestry studies in Maryland that "the general distribution of the loblolly pine is determined by historical and climatic factors, yet its relative abundance

at different localities within its area is determined by the character of the soil."

Having dwelt at some length upon the importance of soil selection for the several different crops, I want to call your attention at this point to the fact that the character of the soil upon which a crop is grown is only one of several factors necessary for successful crop production. Climatic conditions, embracing not only absolute temperatures but also the rainfall, air drainage, soil drainage as affected by topography, — the only kind considered until recently, — elevation above sea level and with reference to local topography, fertilization and care, are all important. No one of these factors may be studied effectually unless the other factors influencing production can be balanced. So soil comparisons can be of value only when the other conditions are equalized, and to do this a large number of field comparisons is essential.

Let us now go a step further, and consider not the adaptation of soils to a given crop, but rather the adaptation of soils to different varieties of the same crop. For some time I have been especially interested in working out the conditions of soil on which each variety of apple does best, and to some of these soil adaptations I now ask your attention. Later any discussion pertaining to them will be welcomed.

Baldwin.

If soils are thought of as grading from heavy to light, corresponding to the range from clay to sand, then soils grading from medium to semi-light fulfill best the requirements of the Baldwin. Following definitely the classification standards of the Bureau of Soils (see table below) with reference to the proportions of clay, silt and sands, this grouping would include the medium to light loams, the heavy sandy loams, and also the medium sandy loams, provided they were underlain by soil material not lighter than a medium loam nor heavier than a light or medium clay loam of friable structure.

Scheme of Soil Classification, based upon the Mechanical Composition of Soils.

[Millimeters.]

<table>
<tr><th>Class.</th><th>1.
Fine Gravel.
2-1</th><th>2.
Coarse Sand.
1-.5</th><th>3.
Medium Sand.
.5-.25</th><th>4.
Fine Sand.
.25-.1</th><th>5.
Very Fine Sand.
.1-.05</th><th>6.
Silt.
.05-.005</th><th>7.
Clay.
.005-0</th></tr>
<tr><td rowspan="2">Coarse sand, .</td><td colspan="2">More than 25 per cent of 1, 2.</td><td>–</td><td>–</td><td>–</td><td>0-15</td><td>0-10</td></tr>
<tr><td colspan="3">More than 50 per cent of 1, 2, 3.</td><td>–</td><td>–</td><td colspan="2">Less than 20 per cent of 6, 7.</td></tr>
<tr><td rowspan="2">Medium sand, .</td><td colspan="2">Less than 25 per cent of 1, 2.</td><td>–</td><td>–</td><td>–</td><td>0-15</td><td>0-10</td></tr>
<tr><td colspan="3">More than 20 per cent of 1, 2, 3.</td><td>–</td><td>–</td><td colspan="2">Less than 20 per cent of 6, 7.</td></tr>
<tr><td rowspan="2">Fine sand, . .</td><td colspan="3" rowspan="2">Less than 20 per cent of 1, 2, 3.</td><td rowspan="2">–</td><td rowspan="2">–</td><td>0-15</td><td>0-10</td></tr>
<tr><td colspan="2">Less than 20 per cent of 6, 7.</td></tr>
<tr><td rowspan="2">Sandy loam, .</td><td colspan="3" rowspan="2">More than 20 per cent of 1, 2, 3.</td><td rowspan="2">–</td><td rowspan="2">–</td><td>10-35</td><td>5-15</td></tr>
<tr><td colspan="2">More than 20 per cent and less than 50 per cent of 6, 7.</td></tr>
<tr><td rowspan="2">Fine sandy loam,</td><td colspan="3" rowspan="2">Less than 20 per cent of 1, 2, 3.</td><td rowspan="2">–</td><td rowspan="2">–</td><td>10-35</td><td>5-15</td></tr>
<tr><td colspan="2">More than 20 per cent and less than 50 per cent of 6, 7.</td></tr>
<tr><td rowspan="3">Loam, . . .</td><td rowspan="3">–</td><td rowspan="3">–</td><td rowspan="3">–</td><td rowspan="3">–</td><td rowspan="3">–</td><td>–</td><td>15-25</td></tr>
<tr><td>Less than 55 per cent of 6.</td><td>–</td></tr>
<tr><td colspan="2">More than 50 per cent of 6, 7.</td></tr>
<tr><td>Silt loam, . .</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>More than 55 per cent of 6.</td><td>Less than 25 per cent of 7.</td></tr>
<tr><td rowspan="2">Clay loam, . .</td><td rowspan="2">–</td><td rowspan="2">–</td><td rowspan="2">–</td><td rowspan="2">–</td><td rowspan="2">–</td><td>25-55</td><td>25-35</td></tr>
<tr><td colspan="2">More than 60 per cent of 6, 7.</td></tr>
</table>

Scheme of Soil Classification, based upon the Mechanical Composition of Soils — Concluded.

[Millimeters.]

Class.	1. Fine Gravel. 2-1	2. Coarse Sand. 1-.5	3. Medium Sand. .5-.25	4. Fine Sand. .25-.1	5. Very Fine Sand. .1-.05	6. Silt. .05-.005	7. Clay. .005-0
Sandy clay,	–	–	–	–	–	Less than 25 per cent of 6.	More than 20 per cent of 7.
						Less than 60 per cent of 6, 7.	
Silt clay,	–	–	–	–	–	More than 55 per cent of 6.	25-35 per cent of 7.
Clay,	–	–	–	–	–	–	More than 35 per cent of 7.
						More than 60 per cent of 6, 7.	

From this broad generalization it will be seen that the surface soil should contain an appreciable amount of sand. The sands, moreover, should not be all of one grade; that is, a high percentage of coarse sand would give a poor soil, whereas a moderate admixture of it with the finer grades of sand, together with sufficient clay and silt, would work no harm. In general, the sand content should be of the finer grades, but soils also occur, though comparatively rare, which would be too heavy for this variety were it not for a marked content of the coarse sands, the effect of which is to make the soil mass much more friable and open than would be expected with the presence of so much clay. Such soil dries quickly after a rain, and is not to be classed as a moist soil. It will never clod if worked under conditions at all reasonable. The subsoil, on the other hand, must never be heavy enough to impede ready drainage of excess moisture, yet sufficiently clayey to retain a good moisture supply; that is, plastic, not

stiff. If the subsoil be so clayey or heavy that moisture does not percolate down through it readily, a Baldwin of poor color with a skin more or less greasy is the usual result.

Referring to the effect of a heavy, clayey soil on the growth and quality of apples, Hedrick of the Geneva Experiment Station, in Bulletin 339, published last summer, states that "The station soil is not an ideal one for apples. Though well drained, the land is yet hard and heavy, and much of the time unworkable, coming from the plow in great lumps hardly to be crushed. In such a soil the root run is limited, — a fact we have had forced upon our attention in early spring, when the soil is wet, by the blowing over of several trees. Manifestly, food would be better utilized by trees in a soil where the roots could develop better. Despite the physical condition of the soil, apple trees make a very fair growth and the fruit sets in abundance, but with most varieties — and the Rome used in this experiment is not a marked exception — the apples run small, fail to color well and do not always mature properly."

The ideal to be sought is a heavy, fine, sandy loam, or a light, mellow loam, underlain by plastic, light clay loam or heavy silt loam. It is fully realized that many will not possess this ideal, but the soil that most closely resembles it should be chosen. If corn be grown on such soil the lower leaves will cure down before cutting time, giving evidence of moderately early maturity. This is one of the safe criteria by which to be guided in choosing soil for this variety.

Mention was not made in the above description of the color of the soil. The desirability of a surface soil of dark brown, the color being due to the presence of decaying organic matter, is unquestionable and generally recognized; and if the soil be not that color the successful orchardist will make it so by the incorporation of organic matter through the growth of leguminous crops, or otherwise. It is often cheaper to buy soil with a good organic content, or humus supply, than it is to be compelled to put it there after purchase before good crops can be secured. Hence this is purely an economic feature. The warning should be stated, however, that a soil should not be purchased or planted to apples of any variety

because it is dark colored and rich in humus. The soil should be selected because of its textural and structural adaptation, regardless of the organic content; then if such soils happen to be well supplied with vegetable matter, so much the better; if not, it may be supplied.

To modify, however, by the addition of humus, the physical condition of a sand until it resembles a sandy loam, or so to change a clay until it resembles a clay loam as far down as tree roots ordinarily extend, is unquestionably an expensive process, and as orchards are grown for profit, the soils on which they are to be planted should be so selected for the different varieties as to furnish the most favorable conditions possible, before going to the additional expense of trying to change their character artificially.

While soils so deficient in humus as to be leachy in the case of sands, but stiff, intractable and cloddy in the case of clays, clay loams, and loams, should have their humus content increased until these unfavorable conditions for crop growth of any kind be overcome so far as possible, it is utterly futile to maintain that by the addition of plenty of humus the physical characteristics of any given soil may be so changed that its inherent physical character is negligible so far as its adaptation to crops or to different varieties of the same crop is concerned. The agricultural practice of the eastern United States is replete with instances of special soil-crop-variety adaptation.

While the hills of Massachusetts include a great deal of ideal Baldwin soil, or soil that resembles the ideal closely enough for practical purposes, they also include a great deal of soil that is not well adapted to the Baldwin. The greatly superior color of the fruit from some orchards when compared with that from others on a different kind of soil — elevation, slope, methods of culture and fertilization being virtually the same — gives striking evidence of the importance of the soil factor. On just this basis the fruit from some orchards sells for a higher price than that from others. This illustrates the economic advisability of selecting the orchard site with soils adapted to the variety to be planted.

Rhode Island Greening.

As the best prices for the Rhode Island Greening are usually obtained in New York City, the general aim of the commercial grower will be to meet the preferences of that market. The demand there for a "green" Greening has usually been stronger than for one carrying a high blush. Bearing this ideal in mind, the soils adapted to this variety are distinct from the Baldwin standard. In fact, these two varieties, considered as standards, differ so markedly in soil requirements that the soil adaptations of other varieties may well be compared with either the Baldwin or the Rhode Island Greening soil standard. A surface soil of heavy, silty loam or light, silty, clay loam underlain by silty clay loam excels for the "green" Rhode Island Greening. Such soil will retain sufficient moisture to be classed as a moist soil, yet it is not so heavy as ever to be ill-drained if surface drainage is adequate. The soil should be moderately rich in organic matter, decidedly more so than for the Baldwin. In contrast to the Baldwin soil in the growth of corn, it should keep the lower leaves of the plant green until harvesting time, or at least until late in the season. Such soil conditions maintain a long seasonal growth under uniform conditions of moisture, and thus produce the firm yet crisp texture, the remarkable juiciness and the high flavor for which this variety is noted when at its best. If grown on a soil too sandy, the Rhode Island Greening lacks fineness of grain, flavor and the juicy quality in greater or lesser degree, depending on the extent of the departure from those soil characteristics which contribute to its production. If a high blush is desired, however, to supply other market conditions, a soil somewhat warmer than that described should be selected, — a deep, light, mellow loam or productive, fine, sandy loam being favorable. To secure a "finish" of this character soils approaching more nearly to the Baldwin standard are best adapted.

The Rhode Island Greening is more restricted in area than the Baldwin, not adapting itself to the climatic conditions as far south as the Baldwin, even though suitable soils occur

there. In fact, its southern boundary may be roughly estimated as $\frac{1}{4}°$ north of the forty-first parallel. South of that it becomes a fall apple, and keeps very poorly.

Hubbardston.

Compared with the Baldwin soil requirements, the heaviest soils desirable for the Hubbardston lap over for a little upon the lightest soils desirable for the Baldwin, while at the other extreme the Hubbardston will utilize to advantage a more sandy soil than most other varieties. This does not mean that it will succeed on poor, light sands, for on such soils the apple will not attain sufficient size to be of value, nor is the tree vigorous enough, but the soil should always be very mellow. A rich, fine, sandy loam to a depth of at least a foot is preferable, and the subsoil may well be of the same texture. A subsoil containing enough clay to make the fine sandy material somewhat coherent, or sticky, is not objectionable, but there should never be enough clay present to render the subsoil heavy. If the soil is too heavy or too clayey the fruit is liable to have greasy skins and a deficient color, while the flavor is insufficiently developed.

Northern Spy.

This variety is one of the most exacting in soil requirements. To obtain good quality of fruit, *i.e.*, fine texture, juiciness and high flavor, the soil must be moderately heavy, and for the first two qualities alone the Rhode Island Greening soil would be admirable. The fact that the Northern Spy is a red apple, however, makes it imperative that the color be well developed and the skin free from the greasy tendency. This necessitates a fine adjustment of soil conditions, for the heaviest of the soils adapted to the Rhode Island Greening produces Northern Spies with greasy skins and usually of inferior color. The habit of tree growth of this variety, moreover, is such as to require careful attention. Its tendency to grow upright seems to be accentuated by too clayey soils, if well enriched, and such soils tend to promote growth

faster than the tree is able to mature well. On the other hand, sandy soils, while producing good color and clear skins, fail to bring fruit satisfactory in quality with respect to texture and flavor. The keeping quality, too, is inferior to that of the Spy grown on heavier soils in the same district. Hence the soil requirements of this variety are decidedly exacting, and are best supplied apparently by a medium loam underlain by a heavy loam or light clay loam. It should not be planted on a soil lighter than a very heavy, fine, sandy loam, underlain by a light clay loam, or possibly a heavy loam. On light soils the Northern Spy very often yields less per acre than the Baldwin. Good air drainage is also very essential with this variety.

Wagener.

In northeast Pennsylvania, where the climatic conditions are not greatly dissimilar to those of this State, Wagener is one of the most profitable sorts for filler purposes. It gave remarkable results, too, in Massachusetts this past year in the eastern part of the State at a very low altitude, and in the western part of the State, at an altitude of nearly 1,200 feet, it is doing very well indeed. The tree is normally somewhat weak in growth, hence a soil that is deep, strong, mellow and loamy should be selected. Stiff subsoils are especially objectionable with this variety; and thin soils, also light sandy soils, should be avoided. The Wagener thus fits in nicely with Northern Spy in soil requirements, and its habit of early bearing makes an effective offset to the tardiness of the Northern Spy in this respect.

McIntosh.

This is an apple of high quality that is now very popular. As McIntosh trees of sufficient age for safe comparisons are rarely available in this State over any considerable range of soil conditions, no positive statement is made concerning the soil preferences of this variety. The indications are, however, that the heavier of the Baldwin soils as described are desirable for the McIntosh.

Tompkins King.

The Tompkins King is fully as exacting as Northern Spy in soil adaptation. The tree, with its straggling tendency of growth, does not develop satisfactorily on sandy soils, but succeeds best on a moist yet well-drained soil, *i.e.,* the light Rhode Island Greening soils, — a soil capable of maintaining such supply of moisture that the tree receives no check at the approach of drought. But the fruit grown on soils so heavy lacks clearness of skin, and the appearance of the apple is marred by the greenish look extending far up the sides from the blossom end, and the lack of well-developed color, which makes this fruit at its best very attractive. Hence the problem is to balance these two opposite tendencies as well as possible, and the soil of the following description seems best to do this: light, mellow loam, the sand content thereof being medium rather than fine, thus constituting an open-textured loam rather than a fine loam. The subsoil should be either of the same texture or only slightly heavier, in no case being heavier than a very light, plastic, clay loam. The soil must be brought to a productive condition. Subsoils inclining toward stiffness in structure should be carefully avoided.

Fall Pippin.

Soils adapted to the Fall Pippin are somewhat wider in range than those described for Northern Spy and Tompkins King. In fact, this variety may be very successfully grown on the soils described for both the Tompkins King and the Northern Spy. It is preferable, however, that the surface soil be a fine loam rather than the open-texture loam described for the Tompkins King.

Grimes Golden.

The Grimes is so similar to the Rhode Island Greening in soil adaptation that a separate description of the soils best for this variety will not be given. The Grimes has been so profitable in some districts under certain conditions of soil

and climate, however, that its desirability for general planting has been widely heralded; and as a result this variety is now being planted in some sections with too little discrimination with reference to both soil and climate.

The best general guide is to plant Grimes where the Rhode Island Greening tends to become a fall apple. This would eliminate it as a Massachusetts sort. That is, the Rhode Island Greening soil, located far enough south for that variety to be undesirable for extensive planting, is well adapted to and may well be utilized for the Grimes. It is recognized that some growers as far north as New York may dissent from this view, but I have yet to see the Grimes grown at its best in the Rhode Island Greening region. The tendency for a considerable percentage of the fruit to be undersized when grown there, is one of the prime reasons why it cannot compete commercially with that grown under more favorable conditions. Besides, it is often not up to the standard in color.

The tendency of the tree to make unsatisfactory growth may be overcome in some measure if planted in soil to which it is adapted. It should never be planted on a light or thin soil, neither on a stiff soil. The tree maintains its best growth on a well-drained, fertile, moist soil, and under such conditions is a very desirable variety in its region. Good air drainage is essential; lack of it makes necessary the elimination of many soil areas that would otherwise be desirable. Its excellent dessert quality makes Grimes a favorite sort both for family and for commercial use. For a special box trade it is particularly valuable.

Even as far south as Pennsylvania the Grimes is less hardy than some other sorts. It is very susceptible to collar rot, and the feeling prevails that a block of Grimes will show many "skips" as early as fifteen to twenty years from planting.

Rome Beauty.

Rome Beauty bears the same relation to the Grimes in soil requirements as Baldwin does to the Rhode Island Greening in their respective regions. There is, however, something of an overlapping of regions; that is, the Baldwin extends

farther south in adaptation than the Rhode Island Greening; and the Rome Beauty extends as far north as the Grimes. But this intraregional overlapping of Rome Beauty and Baldwin is largely a matter of dovetailing due to variations in elevation. Thus in southern Pennsylvania, as the Baldwin in its southerly extension seeks its soil at higher elevations to offset the climatic changes, so does Rome Beauty in its northern extension seek the same soil at a lower elevation for the same reason.

The Baldwin tends to become a fall variety with increasing distance south, and where this tendency is sufficiently pronounced to materially lessen its desirability, it may well be replaced by the Rome Beauty, which is adapted to the same kind of soil.

Rome Beauty is grown with fairly good success in the lower Hudson valley and at low elevations in western New York, but there is some question whether it will become a leading commercial sort in either region.

Ben Davis and Gano.

These varieties are mentioned, not to encourage their planting in Massachusetts, for it is believed that they should not be planted here, but rather to show their relation to other varieties better adapted to conditions in this State.

Both Ben Davis and Gano show less effect from variation in the soils upon which they are grown than any others observed. Their well-known quality is probably somewhat indicative of why this is so, yet there are differences to be noted in the character of the fruit as affected by soil and climate. The latter feature is believed to be of great importance, for while there is no gainsaying the fact that the Ben Davis will grow anywhere and produce fruit of some description, it requires a good deal of warm weather for its best development.

The mere fact that the Ben Davis may well be called the "apple of neglect," because it will probably stand more neglect than any other commercial variety and still bear fruit, accounts for the commercial growers' dictum that it is "a good barrel filler and a good shipper;" while they may

follow this saying with the words, "and that is all." No other varieties are so cosmopolitan with regard to climate, and from New York to Alabama these apples have numerous advocates.

Soils as heavy and moist as described for the Rhode Island Greening are not desirable for either the Ben Davis or Gano. The tree is naturally of strong growth, hence this characteristic should not be intensified by planting on an excessively rich soil, both on account of the growth of the tree and the poor quality and color of the fruit. At the same time, the opposite extreme is not desirable, for if the soil be too sandy the tree grows straggling.

Both of these varieties as planted in New York, Pennsylvania and States farther south in the Appalachian region are bound to prove profitable, but they are not altogether satisfactory. Soils adapted to the Baldwin, York Imperial or Winesap will grow good trees and fruit of both Ben Davis and Gano. Hence there are extensive soil areas, particularly in Pennsylvania, Maryland, the mountainous areas of Virginia and West Virginia that are well adapted to these varieties, and they are also profitable sorts in western New York and in the Hudson valley. But many orchards have been planted, especially in West Virginia, on thin shale hills, where the soils are so poorly adapted to apple growing that not even the cosmopolite, Ben Davis, can bring satisfactory results. This is not the fault of the variety, and in fact the Ben Davis will probably bring better returns from such soils than any other variety. In the southern Piedmont region the Ben Davis drops so early in the season that it is not of commercial importance. In the southernmost Appalachian districts it may be grown, but only for the late fall trade in the extreme southern markets, as there is no call for it farther north.

From careful observation it is believed that the Ozark Ben Davis is a little larger than the Appalachian-grown fruit, and that under the same conditions the Ozark fruit is sufficiently superior to the latter to bring a slightly higher price in market. As a commercial proposition, however, the greater

number of crops secured in the Appalachian region in any considerable period, such as a decade, enables that section to compete successfully in the production of these varieties. A potent point to be considered, nevertheless, by the eastern growers is the outlook for future markets.

While the Appalachian region is admirably adapted to the production of varieties which yield well and are far superior to the Ben Davis and Gano in quality, the Ozarks have yet to find an apple of high quality which approaches the Ben Davis in prolificacy. And although varieties may, and probably will, be developed which will replace the Ben Davis even there to some extent, except possibly for exacting shipment, it is certain to be grown there in enormous quantities for a long time. Hence there is and will be, so far as competition with that region is concerned, excellent opportunity for the Appalachian districts to grow varieties that do not have to compete with the Ben Davis, provided such varieties are grown, packed and marketed in accord with the most advanced methods. But this extra profit which may be obtained from such fruit will never be realized by the slack or average grower. For these two reasons, then, the Ben Davis and Gano are bound to remain as they are now, strong commercial varieties over a large area, but New England can just as well grow varieties of much better quality that will also bring good yields. Hence it would seem ill-advised to make further plantings of these sorts within her boundaries.

We have seen how several of our important crops have reached their highest development on certain kinds of soil, and in the light of this experience it seems inevitable to conclude that soils may be selected for different crops in accordance with their relative adaptations to the growth of such crops. In fact, there is nothing new or startling in this statement. It is simply summing up a long line of experience in the best farm practice of the country. Only the best farm practice, the most perfect soil adaptation and the most effective soil-crop management can long survive, because no other kinds pay as well. We have been forced by competition to

recognize soil adaptation to different crops. It is a matter of economic efficiency.

Attention has been called to the further fact that the best results from certain varieties of some crops have been obtained under definite soil conditions, and this is especially well illustrated by different varieties of apples. Other fruits, such as the peach and the pear, show a similar range of soil adaptability as to the individual variety, but these will not be considered at this time.

Excellent opportunities for fruit culture in Massachusetts are abundant. No other State can grow a greater number of really good varieties of apples, and very few States can equal her in this respect. Yet choice fruit is constantly being brought into the State to supply her wants, while cheaper fruit is as constantly being exported because it is not grown as well as it should be. In common with other northeastern States Massachusetts possesses a climate in which a large number of varieties of apples thrive. Her soils vary greatly, but include large areas in the aggregate which are well adapted to produce all the choice apples the State can consume. This land may be bought, furthermore, at a low price, — in fact, at a lower price than in many States that now ship large quantities of apples a long distance to her markets. Massachusetts markets are unexcelled, and there are plenty of favorable soil areas within the State on sites suitable for orcharding that are adapted to productive varieties of high quality. It seems strange that such opportunities have not been taken advantage of more fully, yet I would not advocate that those without experience, or at least careful study, plant orchards extensively, even under the favorable conditions that Massachusetts affords. Orcharding is a business requiring a high degree of skill and much patience, and there is danger lest some be led by the present popular wave of enthusiasm for the business to engage in it without due consideration of these matters. Yet there is always a good opportunity for any one who will so study the business as to master it, and for such, conditions are highly favorable in Massachusetts.

Mr. Sherwood. I would like to ask what is the best slope?

Mr. Wilder. Ideas differ, but I don't think it makes much difference in Massachusetts. On the Alleghany front in West Virginia peaches are profitable on the eastern slopes, clear up to the top, but on the western slopes, where the conditions are exactly the same, except that in the winter they have sleet storms that are likely to break the trees down, peach growing is not profitable. The reverse is true of western slopes in Georgia and other southeastern States, because there they have very rapid changes of temperature in the spring, and if they can have a northwestern slope it will retard the blooming period a little, so that the blooms are not nearly as likely to be nipped by late frosts. The wind is the principal factor in considering the matter of slope in many cases, and I should not like to plant on any slope where the prevailing wind is so strong that the trees would all lean in any particular direction.

Prof. Wm. P. Brooks. The question related particularly to Baldwin apples, which are valuable in proportion to the high color. Would not the slope affect the amount of sunshine and so the color in some cases?

Mr. Wilder. Undoubtedly; but as the matter of avoiding late frosts is of some importance with the apple, though not as much as with peaches, each individual must be governed by his circumstances, and select the slope for color or for avoiding frosts as seems best in his judgment.

Mr. Jas. F. Rice. I presume the soil on Mr. Smith's farm, which you have examined, represents the soil in this part of the county. To what commercial variety is it best adapted?

Mr. Wilder. The Baldwin would invariably do well on that soil, but I would not assume that his soil represents all the soil in this section, because there is unquestionably a great deal of variation in it. I have in mind two Baldwin orchards in this State and county, each at approximately the same altitude, both on the easterly slope, with the same exposure to sunlight, and having received roughly the same methods of care; but there was a great difference in the soil, and apples from one orchard brought much more than those

from the other. I have great faith in the Baldwin, and while I like to see the new varieties tested out fully, — and some of them will do exceedingly well in the hands of specialists who will give them the particular kind of culture they require, — I recognize that more money has been made with the Baldwin than with any other variety, and I do not believe that any variety is going to take its place. The Baldwin is grown in the northwestern States, but is there called the Oregon Red. Here there is always a good market for the Baldwin, it always sells when of good color, and while it is subject to the disadvantage of being a biennial cropper, there are few varieties that do not have some out about them. The Baldwin is grown in the high altitudes of the southern part of the country, and in northern Pennsylvania, on some very heavy, poorly drained soils, and it is impossible to get good color under these conditions, so we need not fear competition from those sections.

Mr. S. H. Reed. If you saw a field where thorn apples seemed to grow spontaneously, and chestnut, and the several kinds of oak, would it be favorable for a Baldwin orchard?

Mr. Wilder. Yes; you have there a mixture. A light chestnut soil is a little too light, speaking particularly from an economical point, while the thorn apple indicates a little bit heavier soil.

Mr. Reed. Do you prefer brownish yellow subsoil to a yellowish subsoil?

Mr. Wilder. Yes; but I think I would see if I could not make the yellow subsoil brown. The leguminous crops are deep rooted and put humus down into the subsoil and encourage a deep growth.

Professor Brooks. There is a type of soil quite common in Worcester County, the drumlins or rounded hills, with soil usually containing stones and sometimes boulders. Do these not usually furnish pretty good Baldwin soil?

Mr. Wilder. I have found but very few of these drumlins that are not good. Sometimes they have a pretty tough subsoil and the boulders are pretty thick, so it is a bit expensive

to get rid of them, but that has nothing to do with the adaptability.

Mr. George A. Drew. I would like to ask about pear soil, as I think pears can be grown in Massachusetts to a profit more than they are at present. There is an impression that certain sections around Boston and Worcester are better adapted to this fruit than are others.

Mr. Wilder. I cannot answer the question as fully as I might wish. I have had very little opportunity to investigate pears here this summer, and there are very few orchards to be found that have had reasonably good care, so that it is difficult to take observations. I believe that a pretty fairly rich, fine, sandy loam, say a rich Baldwin soil, is the best for the Bartlett. That is not in accordance with common belief, as we are apt to say offhand that pears want a heavy soil, and I think that many varieties do want such soils. The Kieffer which is coarse grained and varies all the way from a miserable thing that no one would want to eat to a fairly good pear, will not stand a sandy soil, because that does not maintain a sufficient moisture supply during the season to produce a uniform growth. The Kieffer is a splendid canning pear and a very fine looking pear, and very prolific, so that a study should be made of soils as regards quality for this variety. I wish it might be possible to spend a good deal of time in the pear districts. Recently there have been very few pear orchards planted in the eastern States, except in western New York, and the old orchards have been going out pretty rapidly, as they have received very little care.

Mr. Reed. How do you account for the poor keeping quality of pears and Baldwin apples as compared with twenty year ago? We used to have Baldwins in April and May, and last year I couldn't get a Baldwin from my own place later than February.

Mr. W. C. Jewett. We had Baldwin apples in our cellars as late as the first of June this summer.

Professor Brooks. I think we are apt to generalize too broadly from particular instances. I should not expect Baldwins to keep very well after our abnormally hot summer of

this year, as they were riper than usual when picked, and therefore will not keep so long. The keeping quality of the fruit of different seasons varies widely. The condition of the cellar or other storage place has a great deal to do with it also.

Mr. Wilder. It is my impression that one trouble about keeping comes from the fact that apples do not receive sufficient care to be of as high standard as they were twenty years ago. Twenty years ago we could get very good apples without spraying; now it is necessary to spray often, and otherwise improve on the care given the orchard, if we are to have the same degree of perfection. This needed care is not given in many cases, and I think this affects the keeping qualities of the fruit.

Mr. John J. Erwin. I think that one trouble comes from the fact that we live a good deal more comfortably than twenty years ago, with furnaces in most houses, so that the cellars are not as cool as they were. I cannot keep apples in my cellar over a month.

Mr. Wilder. For a particular instance of this I know of a grower who used to keep Roxbury Russets away into the next summer, in open storage. He found that he could not keep them in his house cellar, but that they would keep as well as ever in his barn cellar, where there was no heat.

Secretary Ellsworth. Last year one reason why Baldwin apples did not keep well was that they were in such demand that they were sold at good prices much earlier than usual. Prices in the fall were from $2.50 to $3.50 per barrel, but during the winter they went up to $5, $6, $7 and $8, and at the very last of the year sold as high as $9 per barrel. The prices received speak pretty well for our New England apples. I want to ask Mr. Wilder if it is not a fact that through Barre, Hardwick, New Braintree and West Brookfield, and the adjoining towns, we have a naturally fertile soil, where almost any crops can be grown, especially grass, corn and apples, which seem to go together?

Mr. Wilder. That is unquestionably the fact. I drove through this section last summer and was much impressed

with its possibilities. I found one man clearing the rocks off of land at an approximate cost of $100 per acre, to say nothing of the time, energy and perseverance needed for such an undertaking, and he said that it paid him to do it. He was carrying on just this kind of general farming, apples, dairying and so on. If one man can find it profitable to put so much money into increasing his permanent investment, and I will say that when he got the rocks all off, the soil was as good as could be found anywhere — why should we sell our places here and go somewhere else, and pay a higher price for land that is not nearly as good? Here we have the best markets in the world, at least in the United States. These soils, perhaps, are not now in such condition that you could get as good a crop off them next year as you could off the prairie soils of Illinois and Iowa, where the latter are level and productive, but the soil is naturally good, and it can be bought for $40, $30, $25 and even $10 an acre, right in the midst of these rich markets. It seems to me that Massachusetts need fear competition from no section located further west than New England.

Afternoon Session.

Secretary Ellsworth. It is a pleasure to introduce to you Mr. Frederick A. Russell of Methuen, who represents the Essex Agricultural Society on the Board of Agriculture, and who will preside this afternoon.

Mr. Russell. The subject for this afternoon is one that interests all in New England, and especially us of Massachusetts. When we hear what we did this morning of Massachusetts we cannot but feel that we are living in one of the best spots on the continent. I am pleased to introduce Mr. George A. Drew, superintendent of Conyers Farm, Greenwich, Conn.

THE ADVANTAGES OF NEW ENGLAND AS A FRUIT-GROWING CENTER.

BY G. A. DREW, GREENWICH, CONN.

Not so very many years ago it was the general opinion that agriculture held out little inducement as a profession anywhere in New England. If a young man signified his intention of going farming, he was looked on as an object of pity or held up to derision. Even in our own agricultural colleges, where agriculture should have had its stoutest champions, the impression sometimes prevailed that those in authority often felt obliged to apologize or explain their connection with it.

Now all this is changed or fast changing. Farming is no longer looked on as a discredited occupation; the young man sees a future where his father saw only a meager existence of drudgery, and our agricultural colleges are no longer ashamed of having agriculture spelled with a capital "A." Many causes have combined to bring about this result, such as the congestion in our cities, the high price of foodstuffs, improved conditions of country life; but more than all else people have come to a realization that after all there is no place like New England to live in, no place that combines so many advantages and where agricultural opportunities have so long lain dormant.

The cheap land of the west is a thing of the past; the free homesteads there are all taken up; crops can no longer be profitably grown without certain expenditure or intelligent care; in fact, the western country has approached or is rapidly approaching the same agricultural conditions that confronted New England years ago.

New England is the home of conservatism. It is just beginning to dawn upon her that she is still an agricultural factor to be reckoned with; that her soils are not worn out, but only need intelligent care; that she possesses strategic advantages that are of wonderful value. With this awakening she needs more the spirit of the west to see her strong points and let others see them also. With changing conditions she must change as well. The day of the general farmer has gone by. Raising an acre of corn, some potatoes, a few tons of hay, dabbling in poultry, making milk to fatten the contractors, besides harvesting what apples grew in spite of neglect, have in my opinion been the curse of New England agriculture. To be a poultryman, dairyman and fruit grower combined has as much of logic in it as for a professional man to try to be a preacher, doctor and lawyer, all in one. All lines of agriculture have their rewards for those who master their subject. Specialization, in my opinion, is the keynote of the hour. Success depends on the man and his location. Fruit growing has been my specialty; it is on this subject and the advantages New England offers along these lines that I wish to speak.

A few years ago I gave a talk on the growing of fruit in a certain Massachusetts town within thirty miles of Boston, trying to point out what a wonderful opportunity was at its very door; how the town itself was in one of the best natural fruit sections of the State; how this market called for first-class apples, but went to the Pacific coast to get them; how it hungered for small fruits, but had to go beyond the Hudson before this demand could be satisfied. Here was the land naturally adapted to these crops within teaming distance of Boston, in case the freight rates were excessive; here was the market trying to get the best fruit that could be produced, and able to pay for it; yet when I told them that they could produce apples which would sell for as much as, or more than, the highest market quotations, and small fruits also, they thought I had indulged in some flight of fancy, or was carried away by my enthusiasm. "What," they said, "sell apples in boxes for $2 and $3? Why, that is all that we can expect for barrels; and, besides, the commission men want them that

way." "Set out currants where apples in Belmont and vicinity control the market! How can we expect to compete?"

The trouble, my friends, it seems to me, is that we in New England have looked at this fruit business from too narrow a point of view. We have allowed our markets to slip away from us, and given the public the impression that the "big red apple" of the west is the only apple for it to buy. We have got into the habit ourselves of thinking that New England used to raise good fruit, before so many insect enemies and fungous diseases came, but that now the struggle is too unequal. If it had not been for these pests and diseases I shudder to think of the condition fruit growing would be in now. It has been a blessing in disguise. We have to fight for what we get, and nothing is worth having that does not represent effort and skill.

Let us briefly consider some of the specific advantages New England offers. Think what our near-by markets mean to us. Within several hundred miles of Boston are twenty or more millions of people, the great majority of whom are consumers, not producers. Wealth to a great extent is concentrated here. People of means generally buy the best the market affords. It is to these same people that the Pacific coast fruit growers, three thousand miles or so away, are catering; but think what a handicap they are under. It costs them about 50 cents freight to place a box of apples on the market, while with us it is only a fraction of this. We should be able to take advantage of local conditions, but they are often unable to ship their fruit in time for a rapid rise in price.

When I was in Hood River, Ore., last November, the Union was shipping only a few cars of apples daily, when they should have been shipping fifteen or twenty, but they could not get the refrigerator cars, they did not have adequate facilities for storing, and much of the fruit went down. On account of the danger of freezing in crossing the Rockies, it is almost essential that fruit be shipped from there before December 1.

This shows how absolutely dependent they are on the railroads, their only means of reaching the eastern market, while we may be far more independent of them. It is seldom neces-

sary to ship in refrigerator cars, and, moreover, many markets are within teaming distance, while the automobile truck will soon be an important factor.

This nearness to the best markets of the country, then, is one of the greatest advantages New England has to offer the fruit grower; but of almost equal importance is the average price of fruit land. A few years ago we heard much about the abandoned New England farms; to-day this is seldom mentioned. Desirable land here is not cheap to-day by the earlier standards, but compared with the market price of fruit land in the west it would seem ridiculously low. There orchard land without improvement sells as high as $1,000 per acre, while bearing orchards sell for several thousand dollars an acre.

Although our farm values have gone up considerably in the last few years there is still much land in New England which can be bought at reasonable prices, varying, of course, as to accessibility, location and freedom from stumps or boulders. I think that we will all admit that, other conditions being favorable, good cleared land is worth from $75 to $100 an acre for fruit-growing purposes. A few years ago farms could be bought for much less per acre than these figures, with the buildings thrown in.

Another great point in favor of New England is that many of these farms contain old orchards which have managed to exist in spite of neglect. Unless the tree trunks are in too advanced a stage of decay these orchards may be reclaimed and made to pay a revenue almost from the start. Try the modern way of handling these orchards. Cut off the extreme high tops, so that the tree can be more easily and cheaply sprayed, the fruit more economically harvested and the danger from high winds greatly lessened. Clean out the scale, preserve the trunks from decay, get new bearing wood, cultivate and spray thoroughly, and even on these old trees you will get fruit that will surprise you.

We will have to admit that the Pacific coast fruit which is placed on our eastern markets has a wonderful finish which we find hard to equal. The bright sunshine and cool nights there seem to be particularly favorable toward developing

these qualities, which have given them their slogan of "the land of the big red apple," which has attracted the eye of the public and been a great advertisement for their products. Granting them their due, it is time we met them with one of our own, for ours is truly "the land of the *good* red apple," though it is not necessary for an apple to be red to be good. Educate the public to please their appetites rather than their eyes, all the while striving for color and finish. Compare our New-England grown Gravensteins, McIntosh, Palmer Greening, Wagener, Northern Spy, yes, even our Baldwin and Greening, with their Ben Davis, Jonathan, Spitzenburg, Winesap and Newton. The flavor of the home-grown product is without question superior, and this the consuming public should know. It may take time and money, but a campaign of education on this point is worth a great many dollars to New England.

The eastern markets offer a good chance for disposing of the poor grades of fruit which in the west are practically waste. Perhaps I should not emphasize this too strongly as our aim should be to grow as few culls as possible; however, there is a legitimate use to which our poorer grades of apples may be put in supplying the mill towns and poorer class of people, who otherwise would never have any fruit at all.

From a fruit-growing point of view, then, we have the most important factors for success in our favor. We can buy our land at a reasonable figure; we are so near the best markets that we can ship our fruit at low expense and sell it at maximum prices; the apples grown here are of a better quality than those of the west. It only remains for us to take advantage of our strategic location not only to command our own, but to reach out for the world's markets. At present the west holds the commanding position with the choicest grades of fruit. Why? Simply because it is in it on a business basis, is better organized and realizes the necessity of attending to every detail in the most exacting manner.

The two New England Fruit Shows have done much to stimulate interest and point the way we must follow. The high standard set by the last exposition, in particular, must

be the basis, not only for show purposes but for the strictly commercial method of grading and packing.

There are a few growers who already have seen the opportunity and have established their business on a solid foundation, yet how few these are in number; possibly not more than a dozen in all New England.

My aim has been to point out the advantages New England offers as a fruit-growing center, but I dislike to leave it without a word on a few of the essential matters of practical detail.

We are still woefully weak on the thoroughness with which we attend to the various operations, as spraying, pruning, cultivation and fertilization, besides picking, packing and marketing our product.

It is not enough that we prune; we must prune regularly, prune for a purpose, and see that the cut surfaces are protected so that decay may not set in. It is not enough that we spray; we must spray at the proper time, with the proper materials and with sufficient force. This latter point cannot be emphasized too strongly in regard to the first spraying with poison, just after the blossoms have fallen. Cultivate thoroughly the first part of the season; it is the cheapest way to get a sufficient amount of growth. In July or August, when cultivation stops, sow cover crops to save the volatile elements of plant food, and add humus to the soil. Study the plant-food problem, but study it as to your individual requirements.

No two orchards should be fertilized exactly alike. It is a matter you can determine only by experiments. The rigor of the times and results of the harvests are the best criterion to go by. Whatever may be said in favor of mixed fertilizers for general farm crops does not, in my opinion, hold true in orchard work. It costs only a little more to spread the different chemicals separately; they can be put on at a time more suited to crop requirements, and, most important of all, you will save money by so doing. Of all three elements of plant food, the nitrogen should be used with the greatest caution, particularly in a fruiting orchard. Do not overdo it; depend as much as possible for nitrogen upon turning under legu-

minous crops, and then add basic slag or lime to keep your soil from becoming sour.

Thin your bearing trees. It is not until lately that we have come to realize how essential this is as an orchard practice. Begin the latter part of June, when the fruits are about the size of walnuts; pick off all wormy or inferior fruits; see to it that the trees can carry their load. If one thinning is not sufficient, keep at it. This is the way that the westerner grows 85 to 90 per cent of extra fancy box fruit. It is the best paying proposition in fruit growing that I know of, and yet one of the least practiced. New England fruit should be picked with care, and always placed in boxes, not barrels. The westerner considers twenty-five boxes a good day's work; we generally require considerably more. There is no question in my mind, commission men to the contrary, but that we should try to establish a box trade for our best grades of fruit, pack it with extreme care, wrap the fruit, and label it as to grade, number of apples, variety and name of grower. The westerners use the grades, extra fancy, fancy and choice; with us only the first two should be placed in boxes, the poorer grades in barrels.

Of course, this change cannot all be made at once; certain trade will still require first-class fruit in barrels, and must be catered to. In time, however, I look to see all our fancy higher quality fruit in boxes, for the simple reason that the consumer demands it. There is less chance for deceit, and it is a much more convenient size to handle.

I have spoken principally of the apple, because it is the king of fruits, all points considered. There are just as good chances in New England cultivating the peach, pear, quince, sour cherries, grape and many small fruits if attention is given to location. What has been said about the apple in many respects applies to these others as well. This is one of the strong points about New England fruit-growing possibilities, — that its opportunities are not confined to the cultivation of one fruit alone, — for within its boundaries one may find suitable places to grow almost any fruit that will grow in the temperate zone, according to one's preferences and capabilities. There are some who fear the small grower

cannot hold his own with some of the larger developments contemplated. I do not share this view. The one who comes into intimate contact with the work, handles the spray rods and picks the fruit can do it better himself than can another delegated by him.

Possibly a word of caution may not be amiss to those who, without any experience, would plunge headlong into fruit growing as a vocation. It is not a get-rich-quick proposition; time and patience are required; methods which the more experienced consider a life study cannot be learned in a day. Again, there are many who fear overproduction when the orchards now being planted come into bearing. They do not take into account the fact that only a small proportion of trees planted ever come into profitable bearing; that insect enemies and fungous diseases may raise havoc heretofore unheard of; that our population is rapidly increasing, and that there are many people on the face of the globe who do not now have a chance to purchase an apple for a reasonable price. Undoubtedly there will come a period of lower prices, and this will render co-operation a necessity; co-operation will bring better distribution of the product, all of which is as it should be.

I am not one of those who greatly fear this overproduction of fruit. I have heard the same fear expressed ever since I can remember, and it has not come yet. Granting this possibility exists, what about the orchards three thousand miles away, on the Pacific coast? Are not they the ones to suffer, not New England?

Mr. H. J. Wilder. What cover crops would you recommend for northern Massachusetts, at an altitude of from 1,000 to 1,500 feet?

Mr. Drew. Personally I prefer rye and hairy vetch. Rye will grow almost anywhere except where the soil is too wet, and with a leguminous crop forms an ideal combination. I would sow it generally in August, though there might be some seasons when it could be sown earlier or later, owing to drought or unusual rainfall. In the spring I should plow only one way, and let some of the vetch mature. On a soil

where it was necessary to save all the moisture I should plow earlier than on a soil where this was not so necessary. Where a great deal of humus is being plowed in a sufficient amount of lime should be applied to keep the soil sweet.

Mr. Geer. How often do you cultivate your land?

Mr. Drew. An orchard should be cultivated very thoroughly the first part of the year, as it tends to preserve the moisture in the soil. Under ordinary conditions cultivate about once in ten days, sometimes oftener, and keep it up until the latter part of June. Some seasons it would be advisable to run over into July. It depends entirely on whether the orchard is a young or a bearing orchard, and the variety of fruit you are growing. With the Northern Spy I should stop cultivation sooner than with other varieties, because the tendency of that tree is to make too much growth.

Question. In renovating an old orchard would you invariably tear up the sod?

Mr. Drew. In almost every case. Sometimes it is not advisable to plow, as the roots are too near the surface, in which case the use of the cutaway harrow early in the spring, going first one way and then the other, will, if persisted in, accomplish all that is aimed for in plowing.

Mr. W. C. Jewett. Have you had any experience using mulch?

Mr. Drew. Not with the strictly mulch method. I have sometimes, when I was not getting the color I wanted, seeded down and cut the hay several times during the season, letting it lie where it fell. In this way I have grown some nice fruit, and developed better color than I could by cultivation alone.

Mr. Jewett. Mr. Drake, who follows the strictly mulch method, gathering up the grass and placing it around the trunks of the trees, out as far as the branches extend, grows better and higher-colored apples than most growers, and takes the greater part of the premiums at shows around Worcester. In addition, he loses very few apples, as they are not injured when they fall from the trees. He admits that the system is more expensive, in time and fertilizer both, than the cultivation, with a cover crop, but he thinks it the best and cheapest for him.

Mr. J. J. Erwin. Do you advise planting vegetables in a young orchard?

Mr. Drew. I should certainly do something of that sort to pay the first expenses, but I should do it with caution, taking care that whatever is grown does not prevent the tree from spreading out and making a good shaped tree, or cause growth too late in the fall. Too many people get carried away with the immediate results in growing such catch crops, and lose sight of the ultimate results.

Mr. Erwin. Would you grow currants with your trees, or independently?

Mr. Drew. If I grew currants in the apple orchard I should take the greatest pains to see that they were free from the San José scale, as they are very prone to be subject to this insect. I should spray against the scale every year. They do that on the Pacific coast, counting it good insurance, and I think we must come to that in New England.

Mr. S. H. Reed. Which is better for the scale, lime and sulphur, or soluble oil?

Mr. Drew. One is about as good as the other. In bad cases I prefer the oils, as they spread, while the lime and sulphur stays where it is applied. In severe cases I use 1 gallon of oil to 12 of water, although 1 to 15 is the proportion usually recommended. Spraying with oil when the bark is dry doesn't do as much harm and is more effective than when the bark is wet. In the spring, just as the buds unfold, spray thoroughly with lime and sulphur. There is nothing better to clear off fungous diseases and kill the eggs of plant lice.

Mr. Reed. If you have no San José scale, and spray only as a preventive, you would use the lime and sulphur in the spring only?

Mr. Drew. I should; and I should always advise the use of home-mixed solutions, unless a person had only a few trees.

Mr. Reed. Do you put any lime and sulphur solution in with the arsenate of lead in the spring?

Mr. Drew. That brings up to the subject of summer spraying. A few years ago everybody was telling us to use the Bordeaux mixture, and we all admit that it has been one

of the best fungicides we have ever used; but for several years it has rusted the fruit so as to hurt its attractiveness very much. Then came in the commercial lime and sulphur sprays, which, if not used with caution, are liable to injure the foliage, and sometimes do not control fungus as well as the Bordeaux. I have used the self-boiled lime and sulphur solution (Scott's formula; Scott of the United States Department of Agriculture) on apples and peaches. On apples I have used it at the rate of 10 pounds of lime and 10 pounds of sulphur to 50 gallons of water, and then added 2 to 3 pounds of arsenate of lead, spraying just as soon as the blossoms drop. In Massachusetts, where the gypsy and brown-tail moths are prevalent, I would use at least 5 and even 10 pounds of arsenate of lead in cases where the moths were numerous.

The self-boiled solution is one of the cheapest and one of the most effectual solutions for spraying. You take, say, 10 pounds of good rock lime and heat it, or apply enough water so that it will begin to slake, and then sift in the powdered sulphur. Cook the sulphur by the heat of the lime. Let that slake until the lime is all disintegrated, and keep adding water. When a slight orange precipitate is being formed, stop the action by drenching with cold water; otherwise sulphides, injurious to foliage, will develop. Possibly this is a little more complicated than using the commercial solution, but in spite of that I prefer it for apple spraying, and for peaches would not use anything else, only I would use Mr. Scott's formula, — 8–8–50 instead of 10–10–50.

Mr. Reed. How many times do you spray in the summer time?

Mr. Drew. Some seasons vary and some apples vary. The first spraying is the all-important spraying. It should be applied with force, thoroughly and just as the blossoms fall. It should be repeated about two or three weeks afterwards. That generally will be sufficient for such varieties as the Baldwin, and those not subject to fungus. For the Fall Pippin or Spy or Greening, or some of those more subject to a fungus, three or four sprayings are not any too many.

Mr. H. A. Parsons. Is it too late now [December 5] to spray, if you did it on a warm day?

Mr. Drew. No. I should not spray in freezing weather, but it is an excellent time now to spray to kill scale, provided you can have at least six or eight hours without freezing.

Mr. H. A. Turner. If you had part of an orchard bearing the Ben Davis apple would you advise keeping the trees along, or grafting them?

Mr. Drew. That is a matter for an individual to decide for himself. The Ben Davis, from the practical point of view, possibly has a certain function. It will keep better than any other apple, and may be taken out of storage as late as July for culinary use, when you can't get any other apples. I shouldn't recommend anybody's planting the Ben Davis in New England, as they grow apples enough of poor quality in the western States without our doing it here.

Question. Do you spray a limb without any blossoms just as thoroughly as those with blossoms?

Mr. Drew. I should take the precaution of treating it just the same, even if the tree did not show any indication of bearing fruit, just as I would thoroughly fertilize the tree, or a whole orchard, that wasn't going to bear that year. I should not fertilize it just the same, but I should fertilize it.

Mr. Reed. How do you fertilize apples, peaches and pears in both young and bearing orchards?

Mr. Drew. I should fertilize in connection with cultivation, so the trees would make, say from eight to ten inches' growth a year, and produce good colored, sound fruit that would stand up. There is nothing nicer than hard wood ashes to give these results. Manure is all right in giving growth, but in a bearing orchard it should be used with caution. Among chemical elements I should depend on nitrate of soda, but would use it only in small amounts, because it will produce great foliage, but fruit that will not stand up in transportation. For potash, I should use high-grade sulphate of potash as an annual dressing, at the rate of 100 to 250 pounds to an acre. For phosphoric acid, I generally plan on giving my orchards an annual dressing of somewhere from 400 to 600 pounds per acre, and a lot of our best growers of peaches and apples in Connecticut are using it as heavy as 1,000 pounds per acre.

I believe in setting out orchard trees with the expectation of getting the best results, and so growing them as to get the best results, in six to eight years. With the Spy you could get a result in eight years. You should get a certain amount of fruit from Baldwins in eight years, and some people will get results; but with such varieties as the McIntosh, the Wealthy, the Duchess and the Hubbardston, and quite a number of others, you can get profitable results in from five to seven years. To do that, in the first four years I should grow those trees fast, but not so fast as to make sappy growth. I should use a lot of nitrogen if the soil wasn't such as to contain it; but in the fourth or fifth year I should substitute for the nitrogen heavy basic slag or potash, or some such element. With McIntosh, Wealthy, Duchess and Hubbardston, I should plan to get profitable crops within five years. I am making those varieties do that.

Mr. J. A. Williams. Would you recommend setting out peach trees in between apple trees in a young orchard, thus getting a growth of peaches before the apples come into bearing?

Mr. Drew. A great many successful orchard men are doing that, and still there is an element of danger in it. As a general rule, you can get results from peaches in three or four years, and a peach tree spreads out, and generally when anybody sees the money coming in from peaches — and certainly it is good money when it comes in — he thinks he can keep the trees two or three years longer, and be so much richer, and that is a detriment to the apple trees. As a rule, if I were planting by the filler system I should use a variety of apples like the Baldwin or Greening, and then plant in the filler of McIntosh, Wealthy, Duchess or Yellow Transparent, or something of that class. The Duchess makes a good filler.

Mr. Williams. What do you advise for a distance in setting out an orchard of that kind?

Mr. Drew. I should set my Baldwins 50 feet apart in some soils, — in most soils from 40 to 45 feet apart, — and interplant half that space each way with fillers. In the northern sections of New Hampshire and Maine, where the trees tend to dwarf growth, you might set them closer; but in

Massachusetts and Connecticut, where the soil is heavier, and trees make a good, vigorous growth, the ultimate distance of 40 by 40 feet is not too much. The object of the system is to get the fillers to bearing to help out the expense in the meantime. You must cut out the fillers.

Mr. J. L. Smith. You recommend dwarf trees?

Mr. Drew. The dwarf orchard is a good thing for school gardens, a city back lot or a test orchard, but not for a commercial proposition.

Mr. Smith. Would you put each variety by itself or intersperse them for better pollination?

Mr. Drew. I should not think it advisable to set out a great block of Baldwins without having some other varieties in a block close by to pollenize. I think bees are of great importance in proper pollenization.

Mr. Erwin. Some fifteen or twenty years ago there was an apple season, and then a season when there weren't any. Was it from the fertilizer used or was it the season?

Mr. Drew. I don't know as I could explain why such a season existed. The seasons of plenty and scarcity are comparatively evenly balanced now, probably because the apple is more generally cultivated all over the United States. One section offsets another. Again, a person with several orchards will have some fruit himself every year.

Mr. Erwin. Don't you think it depends a great deal on the man? If a man takes care of his orchard, and uses the right kind of fertilizer every year, don't you think it has a tendency to give him apples every year?

Mr. Drew. Yes; that in connection with thinning the fruit all summer. There is hardly an up-to-date fruit grower in the west who does not thin his fruit very, very thoroughly several times during the bearing season. I don't suppose there are twenty-five people in New England who make this a regular practice. Thinning balances the tree, so that, with the exception of the Baldwin, you can get trees to bear comparatively evenly every year, all other conditions being favorable.

Question. At what age do you set out your trees?

Mr. Drew. For an apple orchard my preference would be very strong one-year-old trees, except in sections infested with

the gypsy and brown-tail moths and many fungous diseases, where I should set strong two-year-old trees. For a peach orchard I should set one-year-old trees without question.

QUESTION. Do you put any fertilizer around the bottom of the trees?

Mr. DREW. No; I do not. I prefer to get the soil into fine condition by planting a cultivated crop, like corn or potatoes, the year before.

Mr. TURNER. For a general orchard of an acre or two what varieties would you set out?

Mr. DREW. In certain sections of eastern Massachusetts, with certain kinds of soil, I should set out certain varieties. The Gravenstein, Hubbardston, Williams and Red Astrachan do very well. But for the general grower there is no safer apple to plant than the Baldwin. For the special grower, who would give particular attention to growing and packing in boxes, there is more money in other varieties.

Mr. JOHN BURSLEY. If you were going to purchase a piece of land for the purpose of going into the fruit business, would you rather pay $200 an acre for land within a city of 200,000 inhabitants, or go into the country and buy it at $20 or $30 an acre?

Mr. DREW. As a general rule I should rather buy the more expensive land. If I were going away back into the country I should want a pretty big proposition, where I could afford to employ quite a quantity of labor. For the distant land I would select winter varieties.

Mr. REED. How do you eradicate the railroad worm?

Mr. DREW. I have never been bothered with it, but know people who have. The only way to control it is to pick up the apples as they fall and feed them to hogs, or dispose of them otherwise.

QUESTION. What preventive is there for borers?

Mr. DREW. None that I know of. You should go over your apple trees at least once a year — peach trees twice a year — and pick them out with a knife or wire. I prefer the fall for this work.

Mr. TURNER. Fifty years ago we used to have magnificent Russets, clear up to the spring; what has become of them?

Mr. Drew. The general market does not call for many Russets. If you have a retail trade and ship them yourself, and people know enough to appreciate them, there is no better apple grown than the Roxbury Russet.

Mr. Asa Dodge. Why have the sweet apples gone from the market?

Mr. Drew. Because there isn't any great demand for them. There is no reason why a discriminating public should not call for some sweet apples, but I should be cautious myself about planting them too extensively.

Mr. Reed. Is it better policy to market your fruit as soon as possible or to store it?

Mr. Drew. That depends on the class of fruit. The poorer grades must be put on the market up to Christmas time, because people have not adequate storage facilities. The first-class apples, as a rule, bring a higher price after the inferior grades are out of the way, and therefore should be held.

Mr. Reed. Do you consider the Wealthy and McIntosh short-lived trees, and use them sometimes as fillers?

Mr. Drew. I don't think we know how long-lived these trees are, because where would we find a Wealthy or McIntosh tree forty years old in New England? So far as the choice of a filler goes, the Wealthy will last as long as is required under that system. The McIntosh is a comparatively long-lived tree, and has a tendency to bear heavily every year.

Question. I have about ten trees of McIntosh in an orchard where there are forty Baldwins, all eighteen to twenty years old. The McIntosh bore the most the first four or five years, — more the first year than ever since. The Baldwin trees haven't borne heavily, but I think they have borne more than the McIntosh. The latter have had the same treatment as the Baldwins, but are not more than two-thirds as large. The soil is a clay loam; I have raised good potatoes on it. I have used no fertilizer save stable manure. The orchard has not been cultivated for the last four or five years.

Mr. Drew. Well, I should make them bear some way. I should try putting on some slag and potash, and should withdraw any source of nitrogen. If that didn't make them bear

I should root prune them. If one method doesn't work, use another. I would broadcast the fertilizer over the whole surface, not up against the trunk, because the feeding roots are on the extremities every time.

QUESTION. Is it inexpedient or a bad plan to set out an orchard if care is taken to fertilize and to keep the earth within three or four feet of the tree dug up for a few years before ready to plow?

Mr. DREW. That method is practically used by one of the best, if not the best, fruit growers in New England, A. A. Marshall of Fitchburg; but in spite of that fact I do not think ordinary people would succeed with it.

QUESTION. Would you set Northern Spies and then graft over to McIntosh or Baldwins?

Mr. DREW. Under ideal conditions that is all right; but you are taking a great many chances, — a dry season when the buds will not take, insects that eat the buds, canker from an imperfect union. There is no question but what the Northern Spy stock and the Tolman Sweet are the strongest.

Mr. BURSLEY. How would you proceed to set trees on rough ground that could not be plowed?

Mr. DREW. I should set out the trees and then spade around them by hand. Hand labor is more costly than team labor, as a rule, but there are thousands of acres in New England where fine fruit could be grown in that way.

QUESTION. What do you think of putting pigs into a piece of land that is rough and stony?

Mr. DREW. I would put the pigs in before I set out the orchard; I would not have them in afterward.

Mr. TURNER. What is the difference between the Snow and the McIntosh?

Mr. DREW. The Snow apple belongs to the same group of apples as the McIntosh. It is smaller, not as delicate in flavor and does not adapt itself to so wide a country. It will keep possibly a little longer, but won't sell with the McIntosh and is too small to box. The McIntosh has all the good qualities of the Snow apple without the imperfections.

Mr. ERWIN. What is your cold-storage system for apples?

Mr. Drew. Our system is to hold our apples in our own cold-storage plant, and that is the ideal way; but the ordinary grower, as a rule, cannot afford to build a complete cold-storage plant, as it is certainly expensive. I should either have a well-ventilated, natural cellar in which to hold my fruit, or pack my very choicest fruit in the fall and put it in cold storage wherever I was going to dispose of it, taking it out as the market warranted. If you can't afford cold storage on your own place you must depend on the cold-storage places in the larger cities.

Mr. Erwin. We have just built a cold-storage plant under the ice and brine system, similar to the one designed by Madison Cooper for the Massachusetts Agricultural College at Amherst. Where a lot of ice is available it seems to be the most economical system from a farm storage standpoint.

Mr. Reed. Can you prevent the fruit from sweating?

Mr. Drew. We prevent its sweating to a certain extent by the use of calcium of chloride. If apples are not put directly from sunshine into cold storage, but their temperature is lowered gradually, they will not sweat.

Mr. Trull. Would you advise any one to set out a peach orchard on newly plowed sod ground?

Mr. Drew. I would not hesitate at all, but I would not let the peaches set in the sod. I see no great objection, other than that it is harder than planting them in soil that has been cultivated for a year.

Question. What do you call a good, thrifty Baldwin tree, five years old, worth?

Mr. Drew. I don't know. A bulletin from the State college gave the estimates by certain correspondents in all the New England States of an apple tree, forty years old, at from $25 to $250. A good, thrifty Baldwin apple tree, five years old, is worth $5 any way.

Mr. J. L. Ellsworth. This financial question has brought to my mind the fact that Mr. Russell had a very, very productive tree last year — a very profitable tree. He won the prize that was offered by the Board of Agriculture last year for the most productive tree. There is no reason why you all should not have just such trees, — 30 to the acre.

Mr. F. A. Russell. This tree was a natural fruit tree. About twelve years ago we grafted it to the Gravenstein. The tree bore only a few bushels each year until last year, when we picked 60 bushels of fruit and sold the crop for $56 out of the field. I did not thin the apples and this year got about 3 bushels, but there is another year coming, when I hope to get 60. The tree must be thirty-five or forty years old. I would like to ask Mr. Drew how much he considered that tree worth?

Mr. Drew. I should figure it at 6 per cent and get at it that way.

Prof. W. P. Brooks. There are one or two facts concerning the questions that have been asked about which I have made a discovery or two. The experimental orchard at Amherst has been managed in a sort of modified grass mulch method; that is, the growth of mixed grass and clover has been cut twice each year and allowed to lie where it has fallen. Until the last year or two the results have been very satisfactory; but last year, in particular, three-quarters of the fruit at least was almost worthless, because it was stung by the curculio. When the fruit is stung it stops growth at that point, a dark-colored or greenish spot is formed, and when ripe the surface is uneven and the interior gnarly. If the grass mulch creates conditions favorable to the hibernation of this insect, as it is believed, it is going to condemn this method absolutely.

My own orchard of forty old apple trees, located not far from the experimental orchard, has, under tillage, fertilization and spraying, increased its product from 10 barrels of miserable fruit in 1908, when I bought it, to 90 barrels of fine fruit this fall.

The question as to bearing every year has been brought in. I presume that many of you personally have Baldwin trees in your orchards which bear a quarter or a third of the tree one year, and the balance the next year. I am satisfied that the character of the season has nothing to do with it. My own explanation is that some time back in the past a certain section of the tree was defoliated, and the part that was not defoliated matured its fruit. And then later, the defoliation having occurred early, that part of the tree had a chance to

recover and make growth, which would enable it to bear a crop the following year. The reason why a Baldwin apple tree does not bear every year is that the energies of the tree are so largely consumed in maturing the crop of fruit that there is not enough energy left to make growth and perfect buds for the following year.

A gentleman wanted to know whether nitrate of potash was not just as good as sulphate. I am pretty sure it is not. We are comparing the two, and find that the sulphate trees are much larger and have given much more fruit.

Putting manure in a cone around the trees is a practice which I should oppose. If there is any part of an orchard that does not need manure or fertilizer, that is the part, for there are few or no feeding roots there.

Evening Session.

At the evening session, held at 8 o'clock, Mrs. Adda F. Howie of Elm Grove, Wis., delivered an eloquent and inspiring address on "Farm homes." By request the lecture is not included in this volume.

Second Day.

Secretary Ellsworth. We are going to learn this morning how to feed the cows and make the milk, and this afternoon they are going to teach us how to get a bigger price for our milk. It is my pleasure to introduce to you the member of the Board who will preside, Mr. Faunce of Kingston.

Mr. Faunce. Last evening it was gentlemen and ladies; I think this morning it will be ladies and gentlemen. I come from the extreme eastern part of the State, where we look upon silos as a measure for a part of the season only. I see here the subject is to-day, "Summer silage," which will make use of the silo the year round. I have heard the gentleman who will address you, and I think he will give you a very interesting discussion on that subject. It is my pleasure to introduce to you Mr. H. O. Daniels of Middletown, Conn.

SOILING AND SUMMER SILAGE.

BY H. O. DANIELS OF MIDDLETOWN, CONN.

The subject assigned to me, "Soiling and summer silage," is one I believe every dairyman is forced to consider more and more as the seasons come and go, especially when we have the conditions to meet that have prevailed during the past two or three dry seasons. I wonder if you were as badly affected with drought here in the old Bay State this summer as we were down in the Nutmeg State. Why, it was so dry with us that we could not raise even a full crop of wooden nutmegs, while the cry goes up all over the State of the short hay and corn crop, and men are selling out their dairy herds here and there, claiming that with the high price of hay and grain more money can be made selling their hay than feeding it for milk production. I have no doubt that one can take a pencil and make figures that will substantiate this statement.

Yet what about the dairyman's bank, — the great interest-bearing, quickly dissolved institution, old Mother Earth, whose cry for help will come when the "golden hoof" of the dairy cow has gone from the farm, and the product of the soil which has robbed her of her fertility is sold in the form of hay, never more to be returned to the fields where once it grew. Do we consider enough the great value of the plant food returned to the soil after the dairy cow has taken her portion? Which would you rather do for a day's work, pitch on a great big bulky load of a ton and a half of hay, and draw it four or five miles to market, with a slow-moving pair of heavy horses, accompanied by a husky son of Poland or Italy, getting possibly $37 for the load, and carrying off at least $6 or $7 worth of plant food from the farm, or hitch up the light driving horse and buggy, or the runabout auto-

mobile, put in a hundred-pound box of gilt-edge butter, and with your best girl, or, better yet, your lifetime helpmate, travel the same road, receiving as much or more for this dairy product, with the satisfaction that you have robbed the farm of less than 10 cents' worth of plant food, to say nothing of the extra fun that can be had on this trip? I want to tell you good people assembled here to-day, and especially the young men, not to overlook some of the great possibilities of a home life on the farm, and some of the enjoyments of owning a splendid herd of dairy cows, as well as to consider some of the problems of feeding and caring for them.

Personally, we at Millbrook farm have gotten so far away from the summer-soiling process, as relates to sowing several varieties of feeds on as many strips or plots of ground, cutting the same and feeding from day to day, that I have been obliged to call upon one of my good friends of Connecticut, Mr. F. E. Duffy, to help me out in furnishing facts to present to you at this time.

Many of you know that we are practicing a crop rotation that furnishes us with all the green feed we need for our herd of cows, and these crops are placed in the silo, doing away with a long list of endless labors as compared with the other system, and which we believe is more profitable. I am glad, however, to have the opportunity of presenting the two systems for comparison here to-day, and I want to call your attention to some charts I have prepared as illustrative of the two systems. In one chart (No. 1) I will endeavor to show you the amount of green feed required to supplement poor pasture, or to be fed with a limited amount of hay if no pasture is available for the five summer months, beginning May 20 and lasting until October 20; also showing the time of seeding and the acreage required for a herd of 20 milking cows. In the other chart (No. 2) I believe I can show a lesser acreage required, or a greater food production from the same number of acres, as practiced by our summer silage system. You will notice, if you will follow me carefully, that to feed 20 cows for five months requires 11 to 12 acres of soil, but by gathering some of the crops and planting

again the same season we can do very well with 9 to 10 acres. Here we have the several crops and areas for soiling 20 cows during the five months of summer feeding: —

Chart No. 1.

Crop.	Seed per Acre.	Time of Seeding.	Area (Acres).	Time of Cutting.
Rye, . . .	2 bushels, . . .	September 10–15,.	1	May 20–30.
Wheat, . .	2 bushels, . . .	September 10–15,.	1	June 1–15.
Red clover, . .	15 pounds, . .	July 15–August 1,	½	June 15–25.
Vetch and oats, .	3 bushels oats, 50 pounds vetch.	April 20, . .	1	June 25–July 10.
Vetch and oats, .	3 bushels oats, 50 pounds vetch.	April 30, . .	1	July 10–20.
Peas and oats, .	1½ bushels peas, 1½ bushels oats.	April 20, . .	1	July 20–30.
Barn-yard millet,	1 peck, . . .	May 10, . .	1	August 1–15.
Barn-yard millet,	1 peck, . . .	May 25, . .	1	August 15–30.
Soy beans, . .	½ bushel, . . .	May 20, . .	½	September 1–10.
Sowed corn, .	20 quarts, . . .	May 20, . .	1	September 10–25.
Barley and oats, .	1½ bushels peas, 1½ bushels barley.	August 5, . .	2	October 1–20.

Chart No. 2. — Crop Rotation for the Dairy Farm.

	I.	II.	III.
Crop, ...	Oats and clover, or rye and clover, or wheat and clover.	Clover.	Corn.
Fertilizer, ...	½ ton lime per acre.	10 loads manure per acre.	20 loads manure per acre.

Crops follow in succession across fields.

Possibilities of crops: —

Oats and clover, 10 tons ensilage per acre.

Rye or wheat, 10 tons per acre.

Clover, 10 tons per acre.

Corn, 25 tons per acre.

1,000 to 1,200 pounds of ensilage are needed per cow per month.

5 acres of clover and 1½ acres of either wheat or rye will feed 20 cows ensilage for five months.

5 acres of land saved for other crops in this crop-rotation system.

A good ration for dairy cows: —

30 to 40 pounds ensilage.

8 to 10 pounds mixed hay.

6 to 10 pounds mixed grain.

In this system we are obliged to use from one to two hours a day, four to six days in the week, to cut and cart to the stable sufficient green feed for 20 cows, which for five months figures up to quite a large yearly expense. And then what about the other seven winter months where one has no green feed or ensilage to help balance the ration? Just hay and grain alone is expensive winter feeding. One feels the need of the silo to preserve feed, when the cows are through with their summer soiling rations. This has led many dairymen to adopt the silo and grow corn for ensilage to feed in connection with hay and grain during this unnatural milk-making season; while the two or three seasons just passed have hastened the conviction that a summer ensilage is a necessity and I believe, whenever tried, is proving more satisfactory than the soiling system.

Now, in regard to the summer ensilage system. We used to try to grow corn enough for ensilage to last our cows from one harvesting of this crop until the next, but as the demand for our milk increased we were obliged to keep a larger herd of cows than the capacity of the silos would furnish feed for, and as the area of tillable land suitable for growing corn was limited on our farm we were forced to consider some other way to furnish feed for these milking cows, so we began by hiring pasture from some of our neighbors to help out in this summer feeding in connection with what green crops we could grow. This in turn did not prove satisfactory, as after the 1st of July we found that no matter how large the acreage of pasture, the cows would shrink in their milk, and with the torment of flies it was hard sledding to keep up the milk supply. Just about this time the Connecticut Dairymen's Association began to hold field meetings at some of the dairy farmers' homes, and at one of these meetings, held at the home of Thomas Holt of Southington, one of our most progressive dairymen, we learned for the first time of the possibility of preserving oats and clover in the silo. We found him feeding his cows on a splendid, sweet, very palatable ensilage made from oats and clover growing there. It opened up new vistas of possibilities for us and led us to adopt a system that called for growing a smaller

acreage of corn and more of these protein crops. We had been planting from 30 to 35 acres of corn each year previous to the crop-rotation system we operate to-day, which used up all the available land on our farm for this crop, and which necessitated the planting of corn after corn for many years with the result that we grew less and less tons of ensilage per acre, until we found it a hard matter to fill 375 tons of silo room from this comparatively large number of acres. Our farm measures up to only 72 acres of tillable area, and this is quite widely scattered in 3 townships. The very next season, after seeing the splendid results of oat and clover growing at friend Holt's, we cut off 8 acres of our best corn land and sowed it to oats and clover, with the result that we grew a magnificent crop, the clover growing from 10 to 12 inches high in these oats. I expected to harvest for the silo, but through the objection of my brother, who is partner with me in the Millbrook Dairy farm, I was persuaded to cut this oat crop for hay; but when the second crop of clover came on that season, it was rather wet for hay making, so we put that into the silo with the corn, which made us at least 50 tons of clover silage. When we came to feed that silage, I think it settled the matter for all time with us of the great value it possessed as a milk-producing food. The milk records showed it, the cows' appetites showed it, and the satisfaction of cleaning up a field in a quick and easy manner was supreme. To-day we plan to have 8 to 10 acres of our cornfields in clover and alfalfa, 8 to 10 acres in oats and clover, or rye and clover, and the balance in corn. We grow more tons of food as this chart (No. 2) illustrates than we ever did with the corn ensilage system alone, and the best of it all is we have reduced the acreage of corn until we grow only 18 or 20 acres at the present time, and can keep cows enough together, with the young stock needed to maintain the herd, to supply manure enough to cover all of our tillage fields and grass fields every year.

We spread with a 35-bushel spreader 20 loads of manure to the acre for our corn crop, 10 loads to the acre on our grass and clover fields, and by applying lime at the rate of ½ ton to the acre every third year in our crop rotation system

we are able to grow good crops of clover each time we rotate across the fields. In harvesting the clover we mow with the mower and load directly after the mower with the hay loader, and cart to the cutter, cutting into ½-inch lengths. This is alternated with a load of rye or wheat cut into the silo in the proportion of 2 or 3 loads of clover to 1 of wheat or rye. By planning our crops in this way, and by growing the big Eureka corn, we are able to fill our 375 tons of silo room in September with corn, and in June with 125 to 130 tons of clover and rye, or wheat, so that we can give our milking cows a full feed of ensilage every day in the year.

This season just passed has been the driest in the knowledge of our oldest residents, yet with all of this fearful handicap we were able to keep our milking herd up to a good milk flow. We were obliged to confine our cows in the stable on the fifth day of July, as the heat and drought and annoyance of flies in the pasture were raising havoc with their milk production; yet after confining them for two weeks in our stable, which is large and airy and cool, the milk flow increased so that at the close of the month of July we had produced within 786 pounds of the amount produced in June, which is considered the banner month of the year. The following figures testify to these facts: milk produced in June at Millbrook farm, with 53 cows milking, 36,395 pounds; produced in July, 50, or 3 less cows milking, 35,609 pounds; shortage, 786 pounds. June 25, average daily production, 1,273 pounds; July 5, or two weeks later, cows shrank in milk to 945 pounds per day or nearly 160 quarts less than on June 25. On July 15, or ten days after confining in the stable and feeding a full ration of clover and wheat ensilage and hay with the usual amount of grain, the herd produced 1,094 pounds, or 149 pounds gain over amount on July 5, making up nearly 75 quarts of the 160 quarts shrinkage. Before the end of the month the herd had nearly reached the average of the June milk production, as the figures show only 786 pounds less produced in the month of July.

These figures show to us that in order to keep up a maximum flow of milk all through the summer season we must

provide full rations, and we know of no way so economical as this system of growing clover, rye, wheat or oats and putting them into the silo to tide over the dry pasture period. We find in an average season that we can readily grow 10 tons of green food on an acre of clover, and as much in rye or wheat, so that, allowing 30 to 40 pounds of this ensilage as a day's ration for the dairy cow, or from 1,000 to 1,200 pounds per month, we are able to feed a cow for five months all the green feed she requires with 2½ to 3 tons of this ensilage. Comparing that product with the summer green soiling previously mentioned to feed 20 cows five months, we would need only 5 acres of clover and 1½ or 2 acres of wheat or rye to supply what is needed against the 9 or 10 acres used in the soiling process, with the added advantage of minimizing our work in harvesting and always having a supply right at hand for feeding, to say nothing about the great value to the soil in future cropping by using the crop rotation all over our tillable fields.

In maintaining our permanent grass fields we give them an annual application of 10 loads of manure to the acre, spread any time from October to April, and then as early in April as the land will bear the horses we start the cutaway harrow, — cutting up the surface of these fields quite thoroughly. We sow clover, red top and timothy seed in alternate years on these fields, sowing 3 to 4 quarts of red and alsike clover mixed, and 2 or 3 quarts of red top and timothy; and after following this treatment for four years we find our meadows are stronger and better than ever, with a splendid, firm, full sod, which even in this dry season has cut two good crops. I think we can maintain these grass fields for fifteen, or possibly more, years without taking up and reseeding, as we have some fields that have been cut for over ten years, and the yield is better than it was four years ago.

With the right use of the manure spreader and other modern machines much of the hard labor has been eliminated, and the science of agriculture has become a fascinating study. Why should it not be, when we realize the fact that this soil upon which we tread is not mere dirt, but a living, breathing organism, made up of countless minute atoms,

one square rod of which in a fertile clover field contains more active operators than there are mechanics and workmen in this great country of ours. I would that I could present this matter to you, showing this great truth in such a way that you who are owners of some of the soil of this magnificent country of ours would realize the value of your holdings and would believe with me that it needs only our best efforts, directed in the right way, to make this profession of agriculture as God intended, and as the immortal Washington declared it should be, the most healthful, most noble, and the most useful of all occupations. And yet I can hear you say, "Of what does it avail a man if he gains these good crops of ensilage and hay, and feeds them to a herd of cows whose milk product does not bring enough to pay the cost of production?" True, we can lose if we do not make a careful study of our herds, and see that the cows we keep are capable of giving us a profit. Here, again, we need to use that part of our body that is above our shoulders. God did not intend we should do all our work with our hands and feet. His command was that with the sweat of the brow we should earn our bread, which, interpreted by us who are dairy farmers, means we should keep a pencil close at hand to record the amount of milk produced by each of our cows, and that we should add up this amount each month and each year until we are satisfied which cows are paying us a profit and which are not. Then we should study our needs, looking to the dairy breed best adapted to our use, and sticking to this breed until we have developed such a herd as will be a source of joy and pride to us and, let us hope, to those that come after us. I would most earnestly advocate that all those engaged in dairying breed up their own herds as far as possible, and then, by co-operating with others in the buying of our grain feeds and in the selling of our dairy products, we can become more able to meet and overcome the obstacles connected with our work. With all the modern equipment that genius and science is working out for the good of all mankind, we who are on the hillsides and in the valleys of our beloved commonwealth need have no thought that our position in life is not desirable, for, with the telephone, with

electric lights or acetylene gas, with water piped from the best springs, with steam heat and modern sanitary toilet and bathrooms in our country houses equal to the best system that can be found in any of our cities, and with the last great barrier, isolation, overcome by the quick and powerful automobile we are in a position to-day to get the greatest enjoyment out of life on the farm.

The CHAIRMAN. The preliminary remarks of the gentleman remind me of a story one of our friends told us. A man crossing the Atlantic was pretty seasick, and sent for the commander of the steamer, and said, "I would like to have you take care of my remains." Later he sent again, and said, "Your services won't be needed, for there will be no remains." I want to say to Mr. Daniels that he has covered the subject so well, I don't see how there can be any remains, but if anybody wants to ask a question, Mr. Daniels is ready to answer it.

QUESTION. Do you use a roller or any other means of smoothing the ground after harrowing?

Mr. DANIELS. Yes; we use a roller after scratching the grass seed in with our big weeder. The weeder is at least 11 feet wide with a spring seat on it.

I have given you an illustration of the practical application of this summer silage feeding to our cows during this dry season. It is the thing that saved the day, and if you were to go over these records with me you would find that the cows kept up a uniform production of milk. It is our ambition to have 50 cows that will produce 8,000 pounds of milk a year. With 63 milking we have reached as high as 7,300 pounds.

Now there is one other thing to help along the cause of producing milk economically, and that is the co-operative purchasing of our grain. Many of you are buying grain at the retail price; we have been for years in our State, and we have paid the dealer from $2 to $5 a ton more than if we had organized and bought by the carload. After thinking it over and talking it over we finally called a meeting of our

neighbors, and organized the grain buyers' club. We drew up articles of agreement in providing that each signer should subscribe $100 for a period of six months or more for the purpose of co-operating and buying feed. After four months, if for any reason a member wished to withdraw his portion, a written notice was to be given sixty days in advance. The money is held in trust by a treasurer. The feeds are sold to members at an advance price of 50 cents a ton over the purchase price, 25 cents of which goes to the purchasing agent for his expenses, and the other 25 is paid to the treasurer as interest on the investment. It does not make any difference whether you use 1 ton or 5 tons, that ton of grain is charged the 25 cents by the treasurer as interest on the investment, and the oftener it is turned over the more the interest will increase during the season. All grain must be paid for in thirty days, and it is strictly understood that thirty days means thirty days and not sixty, for if we are going to do business with that little amount of money, we have got to consider it so. Any necessary demurrage shall be met by the members; that unnecessary by those responsible. And this agreement is signed by each member of the band, and each member holds a copy of it, and it holds each one of us to the fact that this is a business proposition. If we deviate from it, we go back on our word.

We found that the first car of feed we got, with the expense added to it, was so little over the carload price that it makes it possible for us to get a ton or 2 tons, whatever we want, at the inside price. I think that in a year we will be able to get even better prices, because the more feed we handle the more reputation we make and the greater concessions we can get from the jobber on close prices. If this is worth anything to you, you are welcome to it.

Mr. B. W. Potter. I would like information on one or two points. I understand the purpose of this argument is to show that the summer silo is superior to the summer soiling method, and I would really like to know which is the best. Would it not require the same amount of work to fit the land and sow the crops for the summer silo as it would for the

soiling crops, and how much more would it take to get that into the silo than to the cows? Again, why is Mr. Daniels afraid to plant corn on the same ground year after year? I have planted corn on the same field four years in succession, and every year it has been better than it was the preceding year. My neighbor, Mr. Jewett, has a field of corn which he has planted some six or seven years, and it has grown better every succeeding year, with a record yield last year in spite of the drought.

Mr. Daniels. I am very glad this question is brought up. It has been four or five years since we ceased soiling our cows from the field, but I can remember distinctly the amount of labor required to cut with the mowing machine a crop of oats and peas, a crop of vetch, a crop of barley, some wheat and some rye. Besides, you are carting a tremendous load of water into the stable. In the summer silo system you can use a hay-loader, which saves much work; yet it is not policy to have this machine in the field all the time for loading green fodder. With 7 men working we can put in 60 tons of silage in three days, and that 60 tons will feed 20 cows five months. Three days with 7 men is only twenty-one days with 1 man. If we were to go after green stuff four days in the week for five months, it would figure up to more than twenty-one days, and it usually takes an extra man. Silage is in a condensed form; it is easier to feed, and gives a uniform production of milk. I have records at home that will not show a variation of 10 quarts a day with 50 cows milking. We couldn't do that with all kinds of feed in the summer. The matter of plowing and harrowing and planting, too, must run up a tremendous amount of labor compared with the use of the wheel harrow.

We planted one field of corn sixteen years continuously, and the sixteenth year the corn crop was worse than any preceding year. There wasn't humus enough put back into that soil; it wasn't mellow; it wouldn't absorb water. I admit that you can for three or four years raise corn after corn continuously, but believe me that any one who practices that method for at least ten or fifteen years will meet the same conditions that we met.

Mr. Adams. When you sow the rye in the fall, after taking off the corn, do you plow the ground again or just use the cutaway harrow?

Mr. Daniels. The cutaway and spring-tooth harrow. We use a grain drill and find that drilling the grain is a whole lot better than broadcasting it by hand. The drill helps to pulverize the soil so that the crop has a better chance to grow.

Mr. J. J. Erwin. Can you raise better corn on sod land than on old land?

Mr. Daniels. Yes; that is why we do it.

Mr. S. F. Reed. I would like to ask Mr. Daniels if I understood correctly that it was about an even thing in the matters he has described to make milk at 5 cents a quart?

Mr. Daniels. Yes, I believe it is. The milk producers of Massachusetts are on the losing side of the game with 1 cent more a quart and sending milk to Boston. You could do a whole lot better by organizing the little creameries that we had a few years ago, or by separating the cream, sending that into market, and keeping the skimmed milk on the farm for raising the dairy cow that the trade demands. The cow that will produce 10,000 pounds of milk per year is the profitable cow, and you can raise her for less than you can buy her. There is not much margin in milk at 5¼ cents a quart because hay is so high.

Mr. Reed. What is a grade cow, that will give 10,000 pounds of milk, worth on the farm?

Mr. Daniels. At least $100; probably more. A cow that produces 5,000 pounds will probably turn the wheels of your machines only, and the other will give 60 times as much profit as the cow that gives 5,000. That is the actual computation as I figured it out, the difference in value of the 2 cows.

Mrs. Adda F. Howie. Do you raise all the roughage for your entire herd?

Mr. Daniels. Yes, we have 72 acres of tillable land and carry 100 head.

Mr. Reed. What was the cost of grain for one year for that herd?

Mr. Daniels. We have 60 cows milking, each one of which required 2,500 pounds of grain per year, which makes a total of 75 tons for the herd.

Mr. Erwin. Do you use the manure spreader the year round?

Mr. Daniels. All the time except when there is not a crop occupying the ground. In the latter part of July and in August we use it in connection with the sowing of clover and turnips, and begin top dressing some of our fields in the latter month. In September we go on to our mowing fields, and anywhere from September to April we are spreading manure.

Afternoon Session.

Secretary Ellsworth. I will now introduce to you Mr. William E. Patrick of Warren, who will preside this afternoon.

Mr. Patrick. We are to be congratulated upon such beautiful weather on this occasion up here in this fine old town of Barre, and we are pleased to see so many out to hear these lectures and attend these excellent exercises. So far we have heard everything that was good, and we have enjoyed it very much. The speaker this morning many of us have heard before, and he filled the bill. It is my pleasure this afternoon to introduce to you one whom I presume hardly any of us have heard, but whom we shall be very much pleased to hear upon this extremely important question. I introduce Mr. Charles D. North of New York, who will address you on "Sanitary milk production by our present milk producers through co-operation."

THE PRODUCTION OF SANITARY MILK BY OUR PRESENT MILK PRODUCERS.

BY CHARLES E. NORTH, M.D., NEW YORK, N. Y.

The widespread agitation on the milk question which has been taking place recently, particularly among persons living in large cities, may be summed up by saying that there is a growing demand for milk of better character. The improvement desired is one which relates especially to the sanitary characteristics of milk. Sanitarians are demanding milk from healthy cows. In some quarters this demand insists upon the tuberculin testing of dairy cows. In all quarters the demand calls for some control over the numbers of bacteria in milk. The demand includes the prevention of the transmission of infectious diseases through milk, both by control of the health of the dairy employees, and, on the part of many persons, by pasteurization. No one who studies the agitation which is taking place on these matters can deny that it is a serious one, and that it must be admitted that great fundamental changes must soon take place in the milk industry as a whole to satisfy these demands.

Our dairy farmers who are the producers of this milk may well feel uneasy and considerably alarmed for the reason that these changes directly affect their business prosperity. The dairy farmer must know just what the character of the milk of the future is to be, and what system of control is to be exercised over him, in order that he may decide whether dairying as an industry is to be a business in which it is profitable for him to remain. The character of the milk demanded in some quarters is so high that it has already been suggested that our present

milk producers are incapable of furnishing such milk, and that the milk of the future must be produced by another class of men, — men possessed of more capital and with more scientific training, and working their farming and dairy processes on a much larger scale.

It is my personal belief that milk having a sanitary character which satisfies the highest demands of public health experts can be produced by our present milk producers. This belief is not mere guesswork on my part, but is based on the actual performance of the work by a group of dairy farmers who have been producing such milk under my personal supervision during the past year.

In considering the characteristics of sanitary milk, and the measures which must be practiced in its production and handling, it is well to look for a moment at certified milk and the methods of certified milk production. All of us must pay our respects and make our acknowledgments to the medical milk commissions and to certified milk because of the ideals which the certified milk movement has established in the minds of all who are interested in milk improvement. Certified milk is without question the ideal milk. The degree of sanitary perfection practiced in its production and handling furnishes a continual object lesson to milk producers and milk dealers. In the tabulation below is a statement of the more important sanitary measures demanded by medical milk commissions for the production of certified milk.

Certified Method.

What the Farmer does.

*1. Water supply pure.
2. Stable, 1 story.
3. Stable, cubic feet air space.
4. Stable, square feet window space.
5. Stable, ventilation.
6. Stable, drainage.
7. Stable, walls tight and smooth.
8. Stable, ceiling tight and smooth.
9. Stable, floors tight and smooth.
10. Stable, stall space.
11. Stable, gutters.
12 Stable, closed to children, etc.

13. Stable, manure removed twice daily.
14. Stable, manure removed 100 feet.
15. Barnyard clean.
16. Barnyard drained.
*17. Cows, healthy.
*18. Cows, tuberculin tested.
*19. Cows, sound udders.
20. Cows, body groomed.
21. Cows, udders washed.
22. Cows, tail washed.
*23. Cowfeed, no strong flavor.
*24. Cowfeed, none unwholesome.
*25. Milkers, no contagious disease.
26. Milkers, hands washed.
27. Milkers, hands dried.
28. Milkers, clean uniforms.
29. Milkers, iron milking stools.
*30. Milkers, use covered pails.
31. Milkers, warm water, soap, towels.
*32. Milk rejected sixty days before calf.
*33. Milk rejected ten days after calf.
34. Milk removed quickly from milkroom.
*35. Milk cooled 45° in 1 hour.
*36. Dairy house superintendent.
*37. Dairy house employees.
*38. Dairy house employees, white uniforms.
*39. Dairy house room for washing.
*40. Dairy house room for sterilizing.
*41. Dairy house room for cooling and bottling.
*42. Dairy house apparatus for steam.
*43. Dairy house apparatus for power.
*44. Dairy house apparatus for washing and sterilizing.
*45. Dairy house apparatus for cooling and bottling.
*46. Dairy house apparatus, pails, cans, bottles.
*47. Ice supply abundant.

The above table gives only a hint of the sanitary measures required, since to put them in tabular form each subject has been greatly abbreviated. There are also from twenty to thirty additional measures of minor importance which are not stated in the table.

A distinction can be made between measures of primary importance and measures of secondary importance. Experience has shown that those numbers to which stars are attached in

the above table are of such vital importance in the production of clean milk that none of them can be omitted. These are measures which must be borrowed from the certified method of milk production for any modification which may be undertaken.

There is one point of the utmost importance in considering the certified method of milk production. This is that all of the sanitary measures on the list must be performed on the premises of the dairy farm itself and under the auspices of the dairy farmer himself. In comprehending the system of milk production to which I intend to draw your attention later on, it is essential to note that in the certified method each dairy farm is a complete unit in itself. Each certified dairy has an extensive mechanical equipment in its dairy house for washing, sterilizing, cooling and bottling milk, and of necessity such work must be conducted by a first-class superintendent and a properly drilled force of dairy house employees. It is obvious that the performance of such work on a small scale on one farm greatly contributes to the expense and makes a large tax on each quart of milk produced. It also seems clear that a considerable investment in money is involved, and a high degree of sanitary training, on the part of the dairy farmer who has to take so many responsibilities upon himself. These are the reasons why the method of producing certified milk is practiced only by a restricted class of farmers, and why the price is so high that it is purchased only by a restricted class of milk consumers.

But while the certified method is obviously one which is not adapted to the rank and file of dairy farmers, the sanitary measures themselves are capable of a modification and readjustment which makes it possible for the rank and file of dairy farmers to practice the same.

In the tabulation below I have borrowed from the certified list a considerable number of sanitary measures. These I have divided into two portions: the first portion consisting of those which I am satisfied can be reasonably demanded of the dairy farmer and which he can be depended upon to perform; the other group consisting of those processes which can be centralized. It is clear that many of the things done in milk production have to be performed on each dairy farm. On the other

hand, there are many things which can be done at a central station and on a large scale to great advantage. All processes capable of centralization I have placed in the second group.

Dr. North's Method.

What the Farmer does.

1. Cows, healthy.
2. Cows, tuberculin tested.
3. Cows, sound udders.
4. Cows, not in calving period.
5. Cowfeed, no strong flavors.
6. Cowfeed, none unwholesome.
7. Milkers, no contagious disease.
8. Covered milking pails used.
9. Milk cooled with ice water.

What the Station does.

1. Water supply pure.
2. Dairy house superintendent.
3. Dairy house employees.
4. Dairy house employees, white uniforms.
5. Dairy house room for washing.
6. Dairy house room for sterilizing.
7. Dairy house room for cooling and bottling.
8. Dairy house laboratory.
9. Dairy house apparatus for steam.
10. Dairy house apparatus for power.
11. Dairy house apparatus for washing and sterilizing.
12. Dairy house apparatus for cooling and bottling.
13. Dairy house apparatus for pails, cans, bottles.
14. Ice supply abundant.

During my experience of five years as a certified milk producer I found, to my surprise, that milk containing numbers of bacteria which were just as small as the numbers in my certified milk, could be produced in my two old cow stables on the premises, provided the milking was done into covered milking pails, which had been sterilized, and by men who were trained to milk in a clean manner. The surroundings of the cow, and even the condition of the cow herself, provided the udder was reasonably clean, seemed to play only a minor part in the result.

The same experiments conducted by me with others in the unsanitary cow stables of neighboring farmers gave precisely similar results. The idea that a sterilized, covered milking pail in the hands of a man who desires to be clean, and the cooling of milk with ice, are far more important than all other measures mentioned in the list, are principles lying at the bottom of my system of milk production.

In the town of Homer, N. Y., there are at present 29 dairy farmers producing 6,000 quarts of milk daily by this system. The enterprise has received its financial support from philanthropic persons in New York City and was organized by the New York milk committee, of which I am a member. These persons consented to join me in my effort to demonstrate that the rank and file of dairy farmers are perfectly capable of producing clean and satisfactory milk, and that the same can be done at small expense.

An old and abandoned shipping station was purchased in Homer, Cortland County, N. Y., and completely equipped with washing, sterilizing, cooling and bottling apparatus. Dairy farmers in the surrounding country were invited to patronize the station, with the understanding that they would have to conform to the methods of milk production above described. While during the first three months only 3 dairy farmers responded to the call, the number has increased in one year to 29, and there are a considerable number of additional dairymen on the waiting list.

Each morning when the dairy farmer comes to the shipping station with his load of milk he drives up to the first door where his cans of milk are discharged; he then drives to a window where the soiled milking pails which he has used during the previous day are discharged; he then drives to a second door at which he receives a complete outfit of milk cans which have been washed and sterilized, and of covered milking pails in sufficient number to provide for both his night's and morning's milking. All the cans and pails have tin covers to protect them against dust. The dairy farmer also receives cakes of ice for the cooling of his milk, if he is not provided with an ice house.

When he arrives at the dairy farm the milking cans and milking pails either remain on the wagon or are placed in some

closet or small room outside the cow stable. Each farmer is provided with a water-tight box or trough for cooling his milk. At milking time he milks into the covered milking pails, and when each pail is filled the milk is poured into the 40-quart cans which are standing in the cooling trough where the milk is cooled with ice water. The farmers use no strainers or any other dairy apparatus than that above described.

At the central station there is a laboratory where all milk received, both morning's and night's milk, of each dairy farmer, is tested every day. The superintendent of the central station is a trained bacteriologist and chemist. All the processes of washing and sterilizing are done under his supervision. On the wall of his office is a large chart containing the names of the dairy farmers, and opposite each man's name is the daily record of the results of the laboratory tests made upon his milk.

Success in sanitary milk production depends even more on the adoption of sanitary measures than it does upon the character of the sanitary measures themselves. For years men have known what the methods are, but the thing lacking has always been proper means for the enforcement or inducement for the adoption of the methods. It is one thing to tell a dairy farmer how to make clean milk, and it is quite another thing for the dairy farmer to do so.

It has become habitual to suppose that dairy laws and ordinances and dairy inspection by public officials are the surest means and, in fact, the only means of bringing about the adoption of sanitary methods. The point of view taken by those who advocate the enforcement of sanitary laws by dairy inspection is one which assumes that the interests of the milk industry itself are not such as will insure the character of the product, and that therefore force rather than persuasion must be used. This attitude breeds antagonism between the milk producer and the public authorities, so that the milk inspector is looked upon as an enemy by the majority of dairy farmers. It is difficult to conceive of any system of inspection sufficiently comprehensive to prevent contaminations of milk which are not only accidental but which may be the direct result of the antagonism above described. The utmost that can be hoped for as the result of official inspection of dairies is the improve-

ment of external appearances. The ambitions and purposes of the dairy farmer himself are affected, if at all, in a reverse direction.

While it is true that in the course of time the industry would be compelled to adjust itself to sanitary laws and to dairy inspection by an improvement in quality and higher prices, yet this readjustment will certainly be slow, and can only come about after the expenditure of very large amounts of money and the lapse of a considerable period of time.

I recently asked a dairy inspector how long it would take him to transform a dairy farmer, who was producing milk containing millions of bacteria, into one who would produce milk containing only a few thousands, if the place were visited by him once each month. He replied that he thought that in the course of a year he might make the transformation.

The inducements offered to the dairy farmers at Homer for the adoption of the sanitary measures described consist first in the payment of premiums on each quart of milk. One premium is paid for the tuberculin testing of dairy cattle; a second small premium is paid for the use of covered milking pails and ice water; a third and most important premium is paid for all milk containing less than 10,000 bacteria per cubic centimeter. There is also a premium for butter fat. Finally, there are three prizes, first, second and third, for the men who produce the milk containing the smallest numbers of bacteria during the month.

The payment of an extra prize to the milk producers for milk containing small numbers of bacteria at Homer is the chief reason why the dairy farmers have produced milk with that characteristic. That they have been entirely successful in producing milk with very small numbers of bacteria is illustrated by the following table: —

Bacteria Tests, Homer Farmers' Milk.

Name.	August.	September.	October.
1. Sellen,	4,000	2,200	1,400
2. Carr,	2,800	2,900	3,100
3. Rice,	4,000	5,000	4,000
4. C. Pratt,	3,400	1,800	1,500
5. M. Pratt,	2,300	1,300	800
6. H. Jones,	2,300	2,000	1,900
7. Klock,	2,000	1,000	2,000
8. Holl,	4,800	4,400	1,400
9. Rogers,	2,700	5,000	1,200
10. Wilkins,	2,400	2,500	1,200
11. T. Bell,	2,800	1,400	900
12. Perry,	1,500	1,500	1,000
13. R. Jones,	6,600	2,060	1,900
14. Hitchcock,	2,500	1,300	2,000
15. Foster,	3,000	1,600	1,300
16. W. Bell,	7,800	3,200	2,500
17. W. Gillett,	12,000	6,500	2,600
18. S. Gillett,	21,000	1,500	1,300
19. Miller,	2,200	900	800
20. C. Bennett,	3,400	4,600	1,000
21. Burnham,	2,200	700	800
22. Hathway,	2,800	1,100	1,000
23. Williams,	3,000	2,500	1,600
24. Fox,	4,400	4,000	2,400
25. Butler,	3,600	1,800	1,800
26. I. Button,	2,400	2,000	1,800
27. C. Button,	2,200	1,400	900
28. Crofoot,	3,600	2,100	1,300
29. Cummings,	2,300	10,000	2,600
New York City,	12,500	12,500	7,500

Any one familiar with the laboratory tests for bacteria of milk from dairy farms will recognize the fact that the above table is a remarkable record. The figures therein are not averages, but what are known as "medians", representing the middle figure of about 50 tests made of each man's milk during the month. In each case there were about 24 samples testing

worse, and also 24 samples testing better, than the figure given. This figure, it is thought, fairly represents the character of the milk. At the bottom of the table are given the bacteria counts of the milk as received in New York City during those months, which figures are obtained in the same manner.

To pay farmers on the basis of bacteria in milk makes necessary the location of a laboratory within easy reach of each farm. The daily analysis of the milk in the laboratory for bacteria is a most potent influence. The record is carefully watched by each farmer because it means financial profit or loss. Therefore, we must put down the bacteriological laboratory as being a factor of utmost importance in insuring the practice of sanitary methods. The dairy farmers recognize that any neglect on their part is immediately reflected in the laboratory test. As one of the men expressed it, "the laboratory can watch the milk far better than the inspector can." I wish to say that it is my opinion that the bacteria test for milk far outweighs in importance the value of dairy inspection in that it sets a watch on the milk which can only be matched by the constant presence of an inspector in the cow stable at every milking.

At Homer there is some dairy inspection. The superintendent of the plant visits the farms about once a week. After the laboratory tests had been in operation for several months, and he had made a number of inspections, the superintendent reported to me that the appearance of the buildings and cow stables and the equipment of the farms bears no relation whatever to the laboratory tests. That is to say, some of the worst appearing places habitually produced milk containing the fewest numbers of bacteria.

The scoring of the dairy farms by the score-card system has confirmed this state of affairs, in that the farms scoring the lowest are often at the top of the list so far as absence of bacteria is concerned. One does not have to look far to explain how this is possible. The score cards in use contain no space for the dairy farmer himself. There is no one factor in milk production nearly equal in importance to the dairy farmer himself. If it were possible to make a score card of the personal character of the dairy farmers at Homer, their intelligence and their carefulness, the superintendent assures me that the men

themselves would rank in nearly the same order as their milk ranks. There is no question in my mind that the man himself is far more important than his equipment, and that a good man can produce good milk amid unfavorable surroundings while a bad man cannot produce good milk under any circumstances.

The 6,000 quarts of milk which the 29 dairy farmers at Homer are now producing possesses a character which corresponds closely to that of certified milk. This milk comes from between 700 and 800 tuberculin-tested dairy cows. It arrives in New York City averaging closely to 10,000 bacteria per cubic centimeter. It fully warrants the statement that our present milk producers are entirely capable of furnishing a milk which satisfies the highest demands of sanitary experts. This can also be done at a cost for sanitary measures alone, as performed above by the farmer and a central station, which makes it necessary to advance the price not more than 1 cent per quart.

It seems obvious that the milk which is to solve the milk problem for large cities must be a milk which the rank and file of milk producers are capable of producing, and which can be sold at a price that is within the reach of the rank and file of milk consumers. An improvement in quality always means some advance in price. Consequently, better milk than we have now must cost somewhat more than the present retail prices.

The establishment of a central, sterilizing station, as above described, in any dairy district immediately eliminates chances of milk pollutions from the farm wells, farm kitchens and wash tubs, and insures the proper washing and sterilizing of all utensils used. The concentration of so many operations in a central plant, under the direction of one superintendent and set of employees, is obvious business economy, and is a great reduction in expenses compared with the multiplication of these things when done on each individual dairy farm.

In summarizing I would say that of all the sanitary measures in the list the washing and sterilizing at a central plant of all utensils, the use of covered milking pails, and the use of ice water are of such efficiency that all other measures sink into insignificance compared to them.

In estimating the value of the plans proposed for bringing about the adoption of sanitary measures, the work described

above indicates that the financial inducement, consisting of a premium to the producer, is the most effective. It will transform a farmer producing milk with millions of bacteria into one producing milk with a few thousand bacteria in the space of twenty-four hours. Next in importance to this is the laboratory control of milk. Laboratory control supplements the premium paid by giving the information upon which the premium is based. Of much less importance than these is the plan of dairy inspection. The external appearance of things must not be entirely neglected. It is easier to produce clean milk amid clean surroundings than amid dirty surroundings. No one advocates dirty surroundings. The field for dairy inspection is necessarily limited to the appearance of things. Appearances have some part to play, but this part is only supplementary to other factors which are of greater importance. Dairy inspection is subordinate in importance to the economic control and the laboratory control of milk production.

If it is admitted that the most powerful factor in bringing about the adoption of sanitary measures is the economic factor, then the solution of the milk problem lies primarily with the milk consumer. It must not be forgotten that the milk industry is a gigantic industry. In the United States the production of dairy farms ranks third in value and is exceeded only by the production of corn and beef. Dairying is the backbone of agriculture. In an industry which is so broad and which affects the interests of such a body of producers and consumers the question of the improvement in quality must finally be settled by the producers and consumers themselves. Laboratory analyses have a part to play. Dairy inspections are also a factor, but above all in influence lies the advance in retail price which must be paid by the milk consumers themselves. When the milk consumers in our large cities are sufficiently aroused to be willing to pay the small increase in retail price which is the cost of cleanliness, clean and safe milk will be quickly obtained. At the present moment milk producers and milk dealers are ready and willing to supply a much larger quantity of milk of this character than milk consumers are willing to pay for.

Mr. Robinson. In producing such milk, how much per quart must the consumer pay over the ordinary price?

Dr. North. This milk is retailed at 10 cents a quart in the city; the ordinary milk is retailed at 9 cents.

Mr. A. J. Pierpont. How do you get the pails from the different places to the station?

Dr. North. All of our pails and cans have tin covers which fit tightly. Each farmer, when he drives up to the sterilizing station in the morning, goes to the first door, where he unloads his milk and also the dirty pails and cans, and then goes on to the next door and gets a new load of clean pails and cans to take home. He gets a double set of pails at each daily trip.

Mr. Pierpont. Do you use milking suits?

Dr. North. Suits are a good thing theoretically, but practically they have nothing to do with clean milk production.

Mr. Pierpont. What is the construction of these barns or stables?

Dr. North. I had some health inspectors from the city and men from the State around there, and they scored all these farms and then handed in the scores to me. You know they are based on 100 per cent; the lowest was 40 per cent, and I think the highest man I had was 75 per cent. The man who scored 40 per cent won first prize that month for low bacteria count.

I want to add one thing. All the milk had to be below 10,000 in bacterial count. My foreman reported that when he got them down to that number he could not get them any lower. So I offered monthly a first prize of $40 to the man with the lowest count. Immediately the count dropped into the hundreds, and a man whose milk formerly showed a count of millions dropped to hundreds in this short while. The theory, then, that the farm which scores the best will give the smallest bacteria count does not always work out in practice, although I would not minimize the score, for it is a good thing to have all the sanitary equipment you can afford. Simply to score these farms will give you no idea of the excellence of the milk, but if you score the men themselves on their intelligence and care you will find the bacteria in almost exact order. The reason this man's farm

scored 40 is that he just bought it, and he has a whole lot of old buildings, and is working his way out of this trouble, and in a year or two he is going to get fixed up. He is a man with plenty of brains and energy. I don't ask him to sprinkle the aisles and the backs of the cows before milking; he thought that out himself. The farmers invent all sorts of tricks to keep the bacteria down themselves, voluntarily. As soon as you get a man inspired in his own mind to do these things because it makes money you don't have to compel him to do them or ask him to do them or insist upon his doing them; and it is not necessary to go out on any dairy inspection as though sneaking out. The inspector is invited out by these men, who want to ask him questions as to how to produce better milk. That is what I mean by co-operation.

Mr. B. W. Potter. Do I understand Dr. North to claim that it would be practical in this State, for instance, for us to abolish all the laws relative to the inspection of milk, and simply sell the milk on butter fat and bacteria count, and if we might, is there any scheme by which it could be done? If that is so it is a revelation to me, and I don't know but it is practical to do away with all these laws about inspection of barns. If the party is simply held to cleanliness, and it shows in the analysis, why do we need any inspection at all?

Dr. North. I think the only law we need in the dairy business is that everything should be correctly labeled, and we need only inspection enough to see that they *are* correctly labeled. I am not here to advocate abolishing the law or the boards of health. The thing to do is not to make more law or use more force, but to bring up a business so that the contract between the producer and the consumer is a businesslike contract. If you want milk that is a better grade have a better price for it.

Mr. F. A. Russell (Methuen). Do any of those farmers use a milking machine of any kind?

Dr. North. None of the dairymen who are furnishing milk for me have sufficient capital to buy such a thing as a milking machine. It is a matter of interest, by the way, to learn that in New Zealand, which is a very progressive

country, they have 16 different types of milking machines, and it has revolutionized the milk business in New Zealand, where labor is hard to obtain.

Mr. Greenhood. Did I understand the speaker to say it was not necessary to kill all the cattle that reacted, and if so, I would like to ask what course he would pursue?

Dr. North. I did say so, yes. I was speaking entirely from the standpoint of a physician when I said it. I believe the majority of dairy cows who react from tuberculosis are not seriously diseased, and would recover if given an opportunity. I don't exactly know how to give them an opportunity. The laws are so firm that it is not a very easy thing for a man to keep diseased cows at home on his farm, and the State hasn't provided any place for them; but owing to the tremendous financial loss to the State as well as to the dairy farmer in having these animals killed, I think that such a place will be provided.

Mr. Potter. I would like to add right here a little experience we have had in Rutland in regard to this matter. The authorities at the State sanatorium in Rutland never had their cows tuberculin tested until two or three years ago, and out of a herd of 45, 32 reacted. They took about 4 or 5 of the poorest ones and had them killed. The rest of them they put up in a separate barn, pasteurized the milk, and fed it to the hogs for one year, then had them retested. They all passed. Those cows went right back into the herd and are there now.

Mr. Pierpont. Why do you insist on tuberculin-tested cows, and do you accept the milk at the same price if the cattle are not tuberculin tested?

Dr. North. We don't accept any milk now except from tuberculin-tested cows. We require the tuberculin test because many authorities demand it. Owing to the fear of transmission of the disease to the consumer through the milk, the New York authorities demand the test. I believe that this danger is present only when the disease is in the udder. But because of the fact that in a tuberculous animal it may at any time reach the udder, the test is required if the milk is to be consumed in a raw state.

Mr. Charles O. Flagg. How often do you make a tuberculin test?

Dr. North. It is made once a year by us on these cows.

Mr. Pierpont. Do you have your own veterinarians make that, or a State veterinarian?

Dr. North. The State veterinarian. We have to have the State veterinarian make it in order to get the State money.

Mr. Pierpont. How much does the State allow for condemned cows?

Dr. North. The maximum in New York State is, for a grade cow, $75, and I believe $125 for registered cows; then the State pays three-quarters of that appraisal.

Mr. Potter. Do you inspect the premises of these farmers?

Dr. North. We do, simply to give the man any advice he wants to earn more money. It isn't for criticism, because, if he is bringing his milk in with a small number of bacteria, we have no quarrel with him. With us it is the result that counts.

Mr. Robinson. How far would it be practical to be from the central station?

Dr. North. One of our farmers carts his milk seven miles every day.

Mr. Adams. Is it cooled before he carries it?

Dr. North. All the night's milk is cooled with ice; all the morning's milk is warm. We have thousands of bacteriological analyses of milk, and the morning's milk in the majority of instances is much better than the night's milk. We would be glad to have the farmer cool it, but it is in 40-quart cans and the time is limited, as they must be at the station by 8 o'clock. This means that it is two to three hours before the morning's milk is cooled. Don't understand me to say that it is not a good thing to cool milk; it has got to be cooled with ice water, and it must be thoroughly cooled and kept cold to prevent the multiplication of bacteria. The question is as to how soon after milking it must be cooled.

Mr. Pierpont. As soon as it gets to your station what do you do?

Dr. North. We run it over a big mechanical cooler. One of our men — the fellow who scored 40 per cent — hasn't got any dairy house at all, or any place in which to cool his milk. He has a barn with a ceiling so low that I can't stand up straight. He wanted to go into this business, and asked me if he put an old horse trough in front of his barn, and put in cakes of ice for a cooler, whether that would do, and I told him it would. That is one reason his premises didn't score any higher, but he took first prize for low bacteria count.

Mr. Daniels. Does a man strain it right into a can with ice around the can, or over a cooler?

Dr. North. We don't allow our dairy farmers to use any coolers or any strainers. When they get the idea of clean milk into their heads, they feel it an insult to the milk and to them to have it strained. When we receive the milk we run the entire 600 quarts through sterilized cheese cloth and cotton, and there is hardly anything in it. When you try milking in a small-mouthed pail and keep your cow's udder clean, you will find nothing in the milk, and it increases your price $20 a month.

Pres. K. L. Butterfield (Amherst). What type of organization is possible for supporting this method of co-operative sterilizing, supposing the farmers want to take it up themselves?

Dr. North. Quite a number of queries have reached me along that line from dairy farmers and large milk dealers, and from boards of health and civic associations, who say they want such milk. In order to organize such a scheme you can either start by getting some big dealer interested, or by locating a group of dairy farmers who will produce this milk. Now, if you can get some people in the city to say they would rather pay 10 cents for clean milk than 15 for certified milk, the problem is solved. In New York city we are running the 15-cent milk out of business. There are plenty of dairy farmers who are capable of producing such milk and winning the premiums; and the majority of the farmers now admit that it doesn't cost any more to keep things clean and milk into a pail with a small hole, while

the farmer's wife is more than glad to be relieved of the washing of pails and cans. The only added expense is the tuberculin test and this must be met.

Mr. Robinson. I would like to ask how much it would cost to establish a sterilizing station?

Dr. North. In establishing this station we naturally wanted to do the thing in first-class style. We bought an old, abandoned creamery, paid about $2,000 for it, spent $6,000 upon the buildings, and it scored 100 per cent when done, the highest in the State; that was because we wanted to make it an advertisement for the business. But I believe for very much less money than that a plant could be started, and my opinion is for about $3,000 or $4,000 from the ground up a plant could be equipped and fitted to handle this thing. We cut out all fancy things and cling only to the things that give results.

Mr. J. J. Erwin (Wayland). How far are you from the city of New York?

Dr. North. I felt when I started this movement that, if I located near New York, the people would say, "You have extra good shipping facilities." So I went 300 miles away in Cortland County, so that when the milk gets to the city, the night's milk is thirty-six hours old and the morning's twenty-four hours old. I think the milk averaged during August 12,500, September 12,500 and October 7,500 in bacteria count.

Mr. George H. Ellis (Newton). I am thoroughly interested in this proposition. It is true that if you can show to the farmers that it is for their welfare to do a certain thing they will do it. Now, accepting the statements of Dr. North, the question for us to consider is how we can apply it in this State. The conditions here are entirely different from what they are in the State of New York. Milk there is supplied by several thousand creameries, while here in Massachusetts in the main our milk is handled by three or four contractors. Now, how we are to handle the proposition is a serious question. Our proposition here is complicated further by the fact that so large a proportion of the milk of the city of Boston comes from outside the State. Now, if this plan

could be applied here in this State to our own milk, and it could be made general, Massachusetts milk would command in the city of Boston and the metropolitan district a higher price. That is what we would like; but how you can apply this system in a large way to-day is a problem. What we need more than anything else, and I assume that Dr. North's proposition carries that with it, is the confidence of the consumers. With that you can get your higher price for milk from the considerable proportion of the consumers. It is true that in every large city a considerable proportion of the citizens will buy cheap milk if they can get it anywhere, — a low-priced milk, no matter how cheap it may be. Now in the city of Boston there are organizations that are doing their level best to educate the consumers, but it is a big problem.

Dr. George M. Twitchell (Auburn, Me.). Mr. Chairman, to my mind, familiar somewhat with the situation as applies to the Boston milk supply and my own State, it seems to me there is one step which is not perhaps entirely neglected, but which is of far more importance than is at first apparent. It seems to me the milk producers sending milk to Boston have been delinquent in their duty in not having established the fact that their responsibility for the condition of that milk ceases when the milk is delivered at the station. Does that hold in Massachusetts? Have you established that fact, or are the consumers charging the condition of the milk back to the producer? If they are, in any degree, then it seems to me there is work to be done at the other end of the line. Start in with the consumer's dishes and means of caring for the product, and follow back until you reach the point where the producer's responsibility ceases. When you producers of Barre land a can of milk at the station for delivery at Boston, your responsibility for the condition of that milk must cease. Up to that point it is upon your shoulders. Whatever gets out of it, or gets into it, or becomes of it afterwards is not a responsibility resting upon your shoulders. Have you made that point of distinction clear, and have you established the fact, for I do not believe there is a milkman who is unwilling to assume a responsibil-

ity which is rightly his? It is the forcing of a responsibility upon him which does not belong to him that has made much of the friction which has grown up in recent years. The statement has been made that 800 cases of typhoid in Boston were charged back to the farmers.

Mr. Ellis. In the particular case referred to the responsibility has been to a considerable extent accepted by the contractors of Deerfoot farm. They have published a pamphlet which has been quite widely distributed, and I think it was established that the 800 cases came through that source of supply. But every case of typhoid which has been discovered in milk not infrequently has gone back to the producer, and to that extent the responsibility of us as producers has not ceased when we delivered that milk to the contractor. If any of the milk when we deliver it to the contractor carries germs of typhoid with it, as has been the case in more than one instance, you couldn't get rid of that. I agree absolutely with Dr. Twitchell, that so far as this increase of bacteria is concerned, and the general question of the condition of the milk, the responsibility of the producer should cease when he delivers it to the contractor, but in the cases of typhoid fever and scarlet fever they have traced it back to the producer in several cases.

Mr. Potter. I agree with Mr. Ellis that the problem is how to apply the truths enunciated to-day, and I should like to raise the question, what is the objection to doing away with our system of inspection? We all know that the system at the present time is complicated and unsatisfactory. Now, suppose we should take the bull by the horns, and wipe all our laws in regard to inspection of milk off the statute book, and in their place make some provision whereby each milk could be properly analyzed, so that the consumers would know that it was pure; suppose that was done and there was a provision made that there should be no milk containing more than say 200,000 bacteria — whatever number you might place it at — and then have another class of milk at another period, and so on. What is the objection to that? We have been racking our brains for years to make new laws to apply to the matter, and we don't succeed. Now

isn't it about time for us to clear the statute books and start new?

Mr. Ruggles. I think that might react on the contractors who buy the milk more than the farmers.

Mr. Potter. Of course that wouldn't affect the local producer, but if the outside producers had to come here and subject their milk to the same test ours is subjected to, why wouldn't that take care of that milk which Mr. Ellis says is the trouble in the matter? If they were required to produce milk as low in bacteria as we do here, let them do it; if they can do it, let them keep it up. Why isn't it a fair system for everybody who produces milk? What is the objection to it?

Mr. Robinson. It would seem that in Mr. Potter's proposition the great trouble would come in the analyses, — where they would be taken. If we had to analyze every man's milk every day we would run up against quite a serious proposition as to where and when that should be done.

Mr. Potter. I don't think it would require that everybody's milk be analyzed every day. We now have a law that we shall not sell milk except with a certain amount of butter fat, and there is a penalty if it doesn't come up to the standard when they do analyze it. If you made it a penalty you wouldn't have to analyze it every day, but anybody caught selling it under that standard would be punished.

Prof. J. A. Foord. Along the line of the remarks of the speaker this afternoon, in answer to Mr. Potter, it seems to me we want a premium instead of a penalty. That has been the trouble, and I think Dr. North brought that out very clearly. I would like to ask Dr. North how to handle the tuberculosis question. It is right in our midst in the human family and the bovine family, and it is our business to fight it. If we are going to have more profitable herds we must eradicate it. We none of us want tuberculosis in our herds any more than we want it in our families. It has been established scientifically that it is transmitted from the animal to the man. It is true the tuberculin test gives us an indication of a very slight number of tubercles, that perhaps might not be serious and cause death, but may go on

from that and cause very serious harm, and perhaps death, to the human family. I would like to ask Dr. North to tell us how we are going to handle the tuberculosis question. Is it fair to ask the government of the United States or each State to pay for the tuberculosis in our own herds? It seems to me right here is one of the most serious problems in the production of milk, and healthy milk, in Massachusetts to-day.

Dr. North. The speaker has asked me a question so difficult that I can hardly hope to answer it, and I don't feel ashamed to admit my inability because I don't believe there is a man in the country who could answer it who would be likely to be correct. I agree entirely with the speaker that it is for the interest of the dairy farmer himself to keep it out of his herd. I believe in the long run he will lose money by not eradicating the tuberculous animals. I am also satisfied the disease is transferred sometimes through milk, especially to children, and I think our milk laws in time will be framed so they will specify that milk must be labeled as to bacteria, butter fat, and as to whether or not the cows were tested. The market itself will decide what it wants to buy. The only trouble now is that all milk is white; it all looks innocent, and no one can tell whether it is good or bad by looking at it. But if the producer and dealer are compelled to label the goods, we shall know what the quality is and whether we want it or not. Now in regard to getting rid of the tuberculous cow, I believe the tuberculin test is the best way, but as to how that is to be done in a way not to bring about great financial loss is a serious question. We have State laws which prohibit the transportation of cattle unless they have been tested. I should like to see the time come when no man could sell a cow or buy a cow without having either a certificate that that cow had been tested within a year, or else that the cow must be tested right then and there. I believe the transfer of dairy cows from one farm to another is the thing that keeps tuberculosis alive. I believe if a farmer was compelled to keep his tuberculous cows at home, the disease would soon die out, because the cow, on his own place, would either get well or die. There is no use in hav-

ing interstate laws, if the State itself can ship around from county to county and keep it alive. It is ridiculous of New York to say, "You can't cross the line from Massachusetts because we don't like your brand of tuberculosis, but our own brand is perfectly harmless, and we can ship cows around New York State all we want, because we like our own brand." That is ridiculous. Now if you can prevent this practice you are going to stop the epidemic. We quarantine a person who has any other obnoxious disease, but we don't seem to think it necessary to quarantine our cows. If we did that we would soon stop the disease. I believe the majority of the sick animals, if isolated, will get well, and the solution can be brought about in that way.

President BUTTERFIELD. Dr. North, no matter how the organization was formed, supposing it was co-operative among the farmers, if 500 cows supplied milk at the central station, would 1 cent a quart pay for the total extra cost of the whole process, any extra expense of the farmers, the interest on the money invested in the stations, the salaries of the two men and the maintenance of the plant, — is that a fair statement?

Dr. NORTH. In that 1 cent a quart I didn't include any extra expense at the station. It costs a little more to run this kind of a station than an ordinary one. It costs the New York station ½ cent to bottle the milk, and in our station it costs 7/10, 2/10 of a cent more. But I maintain that after the farmer gets the extra cent, the dealer at 9 cents is making enough profit, selling the milk at 10 cents a quart.

Dr. BUTTERFIELD. Supposing the farmers organized for this purpose, what allowance in the increased cost ought to be made for the support of a plant of this kind?

Dr. NORTH. One and one-half cents. That would be abundant, more than is necessary. They would own stock themselves, and it is a question whether they would put the premium on it, as the money would go into their own pockets.

Mr. HARWOOD. We would like to have the doctor tell us whether the company who handles this milk found it profitable, with all the extra pains they had to take? Also how many he has on his waiting list in New York State to go

into this kind of work. I should also like to have him state what success he has had in getting the customers to take the milk.

Dr. North. Regarding the commercial success of the enterprise, this business was gone into for two particular reasons. The first was because I was anxious to find out what it cost to make clean milk, and a number of men of wealth in New York City put up the capital for the purpose. The second reason was because in New York they wanted to start 30 depots in the poorer parts of the city for the feeding of infants, and they wanted good milk to use at these stations, which were opened last May. Unfortunately for our business they were closed the 1st of October to our milk. But during that period we were delivering up to 4,000 quarts of milk a day to these stations, where between 500,000 and 600,000 babies were fed. The records show that during this period they experienced the lowest mortality they have ever had. On the 1st of October the philanthropic people decided to carry it no further, and this threw 4,000 quarts back on our hands, and we have since been trying to find a new market for this milk. Now, as a matter of profit and loss — I didn't want to discuss this subject, because I am supposed to be a professional man and not a business man, being connected with this matter only as consulting bacteriologist. But naturally I am more interested in it than any other business, so I had expert accountants go over the books of this company, which has been running only a year, to find out what it cost to make this milk, and they reported that from May 1 to October 1 the cost was 7.7 cents per quart, delivered in bottles to these stations. That included the cost of office expenses, railroad freight, horses and trucks in New York City and salaries of drivers. I therefore feel that I am warranted in saying that at 10 cents a quart there would be a nice profit. That 7.7 cents was based on summer prices, from May to October. The winter prices average a cent more. That would make it 8.7 cents for winter prices. Then there is an additional expense now in trying to sell the milk at retail, — the difference between wholesale delivery and retail delivery. I believe, however, it still leaves 1.3

cents to work with for this additional labor of delivery. The 8.7 cents and 7.7 cents would average, as you see, only a little over 8 cents for the whole year, and that pays the cost of the sale and delivery, because the retail delivery isn't more than 1 cent more on the outside, so we have enough to make a profit at 10 cents a quart. One of the directors of the largest milk company in New York City, and the president of the Fairfield Dairy, hard-headed business men, both say that at 10 cents a quart this company can make a handsome profit.

Now as to the response we are getting from milk consumers. Since October 1 I have had to hunt to see if we could find anybody who had brains enough to pay 10 cents a quart for this kind of milk. We first went to a dealer and asked him if he would be an agent for it, and he said he would, and he is now taking 2,500 quarts a day and selling it at 10 cents a quart. Now we charge that dealer exactly what we pay the farmer plus 1 cent a quart. That 1 cent we charge him for our services. So he is getting the milk for whatever it costs us plus a cent. In regard to selling from house to house to milk consumers, I picked out several blocks where people had the most money, and many of them were known to me personally and many were known to other directors in the work, and we got up a mailing list of 500 people, and I sent personal letters to all of them, telling them of this wonderful milk and how much they were going to get for 10 cents, and some of the other directors did likewise. We hired three men to make a house-to-house canvass among these 500 people for six weeks, and we have got 17 customers. There are at least 30 doctors among the 500, 4 of whom are enthusiastic milk reformers, who are not willing to pay the price we ask. I tell you we may well say it is a difficult thing to bring about milk reform when you can't stir up the milk consumers themselves; but we will find some way to do it, and just as soon as we find that secret, I will be ready to tell you other things, and then I believe we can start this movement anywhere.

Mr. Harwood. Do you find plenty of dairy farmers to make the milk?

Dr. North. These 29 farmers are the 29 biggest farmers in that part of the country. When we went there, there was another creamery located in our town, and it was taking over 200 cans a day. Last summer the proprietor came to me and said, "When you came up here, I was getting over 200 cans a day; now your creamery is getting 75 and I am getting 125; by next spring you will have it all and I will have nothing. There is only one thing to do, — for you to buy me out or for me to buy you out." So we took an appraisal of his property and bought him out. There were 43 farmers in that creamery, all of them anxious to get on to this movement. There are 3 other creameries on that same railroad, the Lackawanna, within a radius of 15 miles of us, and the owners of all 3 have come to me and in every instance offered to give me their buildings and equipment for nothing if we would start this movement in their midst so that the dairy farmers in that vicinity might have the benefit of it. We can find all the dairymen we want to make clean milk, and we can find all the dealers we want to deliver it, but where are we going to find the consumers?

Third Day.

Secretary Ellsworth. I wish to introduce to you as the presiding officer this morning a member of the Board from the Blackstone Agricultural Society, — Mr. J. A. Williams.

Mr. Williams. Mr. Secretary, Ladies and Gentlemen: I know I shall be expressing the feeling of every member of the Board when I say that we all have enjoyed ourselves very much since we have been here in Barre. We have been treated hospitably, surely. We have had fine lectures from the very best talent, and when we go away all of us will take with us thoughts of which we can think and from which, I hope, we all will get some good.

This morning we have with us a speaker who needs no introduction. Certainly I am not going to take up your time, as you all know him, and I know we shall be interested in his remarks this morning. I have the pleasure of introducing to you Dr. Geo. M. Twitchell of Auburn, Me.

Dr. Twitchell. Mr. Chairman, before I take up the

talk of the morning I want to preface it with a recognition which I feel is only just and almost necessary. As a resident of Maine, as a firm believer in New England, its possibilities, its future development; as one who recognizes somewhat, at least, the fact that we stand, and must stand, together in this section of the country, and that while there may be State lines dividing us, yet New England interests are practically identical, I want this morning to bear testimony to my appreciation, and the appreciation of the workers in my own State, of the faithful services rendered by the secretary of your Board in directing and carrying forward the work for New England in the great exhibition at New York. I say this because I want you to know that we of Maine appreciate what he has personally accomplished, and recognize somewhat the services which he has rendered. Some things we regret which cannot now be remedied, but they will not happen again. But, really, so much was done for New England in that exhibition, it made such an impression on western thought and conception of what is being accomplished here, that it seems to me we can hardly realize the value of the services rendered.

A subject has been given me which to my mind is very vital in the work of the farm of to-day.

THE RIGHTS OF THE PRODUCER IN THE CONSUMER'S DOLLAR.

BY DR. G. M. TWITCHELL, AUBURN, ME.

History is making rapidly, and no man feels the jolt more forcibly than the observing, thinking worker on the farm. Old-time conceptions and standards have been shattered and new and complex relations force themselves in the path of the average man. Competition, which was once considered the life of trade, is now a thing of the past, and the gentlemanly agreement faces buyer and seller.

So thoroughly are all the avenues of trade organized that in most remote sections we touch great combinations and feel the force of that old-time saying that "in union there is strength." In the rapid increase of urban population there has necessarily followed a division and subdivision of channels of trade and a multiplication of hands through which, under old-time methods, products must pass to reach the consumer. Naturally these hands are sufficiently mucilaginous to catch and hold some portion, to the loss of the producer and burden of the consumer. Inevitably the chief point of attack has been along the line of least resistance. and the power of a combination or corporation against individual units has given a control intensely oppressive and steadily increasing. Thus the farmer has been the greater sufferer. All the while it will be well to remember that these mills, factories, corporations and combinations produce nothing. It is their province to change the character or form of crude products, and thereby add to their value and the

service they may render. In attempting these transformations there has resulted a perfectly natural state of affairs, — the close banding together of all factors for the purchase, change and disposal of products. The generic principle at the root of these combinations cannot be called in question. It is when they reach out and assume to oppress or dictate trade conditions, arbitrarily check competition, and close avenues for the disposal of products by individuals that they become a menace and must be controlled by law. As the producer stands as an individual unit he naturally receives the full force of this combined influence and suffers thereby.

Between the man who produces and he who consumes there is a broad chasm into which falls 65 cents out of every $1 paid by the consumer. This acts and reacts to the loss of the man who produces, in that the consumer naturally charges extortion and high prices back to the farmer. The injustice of this perfectly natural charge is apparent to those who are at all familiar with the situation, but not as easily discerned by the artisan who is so vitally concerned with the problem of the high cost of living. Intentionally or otherwise this class receives the impression that the farmer is fattening out of its earnings, and that responsibility for the high price of any commodity is to be charged entirely to the man who produces. It should be obligatory upon every man interested in the future development of agriculture to keep constantly before the mind of the consumer the fact that to-day there is an increasing number of corporations and individuals standing with open palms. of liberal dimensions, on the middle ground, demanding full share of the toil. It is folly to charge responsibility to any one factor. It may be true, as a western railway official declared, that "the rate upon any farm product is what the industry will stand," but we must bear in mind that very often truckage per package ½ mile exceeds transportation 200 miles, and that other representatives claim 25 to 100 per cent as their share. For this reason there should always be careful investigation before any discrimination can justly be made, — surely before one can assume to cry extortion on

the part of any one agent. We meet here the outgrowth of a condition now oppressive, but the remedy will be found not in abuse or recrimination, but in a study of the steps leading to the present situation.

The fact is, the consumer is very largely responsible for the present range of prices. The corporations or individuals standing between the producer and the consumer have taken advantage of an entirely faulty position and grown exacting with acquired power. Our present habits of purchase of daily supplies in minute quantities, insisting always upon delivery of every item, materially increases expenses. Instead of providing a winter's supply, as formerly, we now buy by the half or quarter pound, or pint. The iniquitous practice of purchasing only one day's supply has given opportunity and excuse for oppressive charges. Thus, in New York, when potatoes sold for 75 cents per bushel, those buying 1 pound at a time were paying $4.20. The potatoes for which consumers paid $60,000,000 last year in New York netted the farmers less than $8,500,000. Cabbages which sold for $9,125,000 brought the farmers $1,800,000, and milk which sold to consumers for from $48,000,000 to $49,000,000 brought the farmers $23,000,000.

Eliminate the necessary increase caused by this practice of purchasing in pound and half-pound quantities or less, and we still have a chasm of tremendous proportions to be bridged. Our 5-pound package of buckwheat for which we pay 25 cents, means $2.75 for what the farmer sells for $1. Cracked wheat sells for 5 cents per pound, while the farmer gets 70 to 90 cents per bushel of 56 pounds.

A wholesale dealer in New York sends the following statement to the "New York Times," showing the difference between wholesale and retail prices for one week in early spring.

Quoted Prices.	*Wholesale Prices.*
Strawberries, 20 to 40 cents a box.	Strawberries (wholesale), 6 to 10 cents; Jerseys, 7 to 10 cents per quart; Delaware, Maryland and Virginia, 6 to 9 cents; Norfolk, fancy, 7 to 8 cents.
Apples, $1.50 per dozen (Newtown and Arkansas Black).	Apples, $3.25 per box, 7 to 10 dozen to the box.
Asparagus, 20 to 40 cents per bunch.	Asparagus, $1.25 to $2.50 per dozen bunches.
Spinach, 20 cents per half peck.	Spinach, 30 to 60 cents per barrel, 24 half pecks to the barrel.
Green cabbage, 10 cents each.	Green cabbage, 25 cents to $1.25 per barrel or crate of 50 to 60 cabbages.
Tomatoes, 25 cents per pound.	Tomatoes, $1.75 to $2 per crate, 24 pounds to the crate.
Cucumbers, 10 cents each.	Cucumbers, $1 to $1.50 per basket, 60 to 100 cucumbers.
Eggplants, 15 cents apiece.	Eggplants, $1.50 to $2.50 per crate, 50 to 60 eggplants.
Cauliflower, 25 cents each.	Cauliflower, $1 to $1.75 per half barrel, about 30 cauliflowers.
Rhubarb, 3 bunches for 10 cents.	Rhubarb, $1 per 100 bunches.
Bermuda and Florida new potatoes, 15 cents a quart.	Bermuda and Florida new potatoes, $2 to $4 per barrel, about 80 quarts or 2½ bushels.

These "wholesale" figures do not represent what the farmers and gardeners received. Out of these prices must come freight and expressage, cartage and commission, assuming that returns were made on the actual sales at these "wholesale" prices.

"Last summer an Indiana farmer delivered 1,600 watermelons in a car for $14, a little less than 1 cent apiece. For these same watermelons we paid here in the market, in Iron River, 50 cents apiece," says a Michigan writer in "Rural New Yorker."

It is not necessary to multiply illustrations or go far from home to find the same, for the conditions are general. Through the workings of this gentleman's agreement many of the retailers dare not purchase from farmers, but must

receive supplies through wholesalers or the commission dealers. The claim is made that business is simplified and a regular supply made dependable, which is doubtless the case; but what shall we say for the man without whom there could be no supply? His rights are totally ignored and he has no position in the chain of recipients fattening on his labor.

With these facts becoming more and more oppressive yearly, with the grower a silent factor in the transaction, his privilege being simply to take all the chances of drought or flood, heat or frost, to combat all the host of pests and diseases, and finally turn his crop over to accept what somebody else is willing to pay, less the total of a surprisingly long list of items of expense, there can hardly be incentive for increase of crop production.

In the face of this situation the President of the United States and a host of others have been preaching the gospel of conservation of fertility, by which crop production might be so easily and quickly increased. President Taft says: —

> The way in which the States can help to meet future increased demand is by investigation and research into the science of agriculture, and by giving to the farming community a knowledge which shall enable them better to develop the soil, and by educating those who are coming into the profession of farming. It is now almost a learned profession.
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> The first great step that has to be taken in reformed agriculture is the conservation of the soil.

Granting that we have been soil robbers for two or more centuries, granting that the conservation of fertility is of great importance, you can never stop the robbing or increase crop production until there is an incentive. This attempt to throw all the responsibility for high prices and threatened shortage upon the producer is wholly unjust and a positive hindrance to agricultural development.

Cease this tirade against the farmers and improvement will follow. Help correct conditions and put the producer in closer touch with the consumer and an incentive will be

found at once operative and effective. There are robbers in the field outside of those who rob the soil, and if they work under the sanction of law they surely creep close to the border. Give us a rest from this wearisome cry of the farmer's obligations, no matter what its source, and help boost him where he may realize 65 instead of 35 cents of the $1 paid. Instead of expending thousands of dollars to furnish an object lesson in crop production, let the railroads make as fair a rate on farm products going to market as on manufactured products shipped in or out of the State. All the incentive necessary for increase will come naturally when this injustice is removed, yet it is but a single factor in the case.

A leading scientific authority in a recent address in New York, on "High farming and low prices," set forth a scheme for raising twice as much corn per acre as is now produced. Thus Iowa in a banner year gave 340,000,000 bushels which sold for 38 cents. The next year the crops dropped to 270,000,000 bushels and the price was 55 cents. Now if this authority could lift the volume to 500,000,000 bushels the price would drop to 20 cents or less. The bigger the crop the less the growers realize. Important as is increased production per acre we must always bear in mind that high farming is not a remedy for low prices. The tariff board in its valuable report, in commenting on a $23 suit of clothes, says, "The farmer received 68 cents profit on the wool required (a per cent to be cut one-half in actual practice), the manufacturer 28 cents, the wholesaler $2.18 and the retailer $6.50." In the face of these facts what incentive is there for the farmer to increase his flocks?

When by any method the rights of the producer are recognized, and he is insured a fair net return for what he produces, the New England farmer will at once respond, and the maximum production per acre or per animal will be the objective point with every worker. What he needs most to-day is not object lessons in cropping, but equalization of burdens in disposal of surplus farm products. He wants only his rightful share of the consumer's dollar.

Improvement comes always through enthusiasm, not force,

and to insure this there must be the certainty of recognition not now accorded. We must have an impelling attraction to lead out into the field so clearly outlined by the host of speakers who view the situation wholly from the standpoint of the consumer or dealer, never from that of the farmer. Give the producer a living share in the consumer's dollar and a new life would be injected into the whole agricultural problem. The question is not alone what does the producer get per pound, per quart or per bushel, but what proportion does he get of what the consumer pays. While he struggles to grow the crops and make the products, denying himself that he may live, there is before him continually the certainty that his share in every dollar paid by the consumer for what he grows is less than 35 cents. Let the President and the railroad magnates, who are so frank in lecturing the farmer about increasing volume per acre, assist in increasing cash per acre, and the furrows would multiply and harvests increase.

The greatest obstacle encountered by the student, thinker or worker to-day in the agricultural field is this combination of factors which stand between the producer and consumer, a combination united, powerful and exacting. It has not come in a day, but has been the growth of years, and its avenues of control are extending yearly over rural life. It closes cold storage plants when growers decline to sell. It unloads upon the market to break prices. It stops factories to check volume, and the grower is helpless because there is no competition. When producers attempt to organize for self-protection, to insure a living price for any commodity, the cry of restraint of trade is at once heard and injunctions are issued promptly from our courts. With public speakers and the press so prompt in placing emphasis upon the importance of lifting production per acre, or per animal, to provide the food of support for our rapidly increasing population, while trade combinations are extending their power to check protection for the grower, the farmer is between the upper and nether millstones.

I do not stand here with any thought of solving this great problem, but simply to suggest what seems natural and inev-

itable, if any change is to be effected. As this condition we deplore has become possible through confidence, man with man, so must the remedy be reached. Combination must meet combination, and that this may be possible, confidence must first be established throughout rural sections. The conservatism of rural life and habits of isolation have inevitably strengthened the spirit of self-reliance and weakened that of dependence upon others. A sarcastic old farmer declared that "the average man on a farm would rather lose $1 than see his neighbor make $2." This spirit is the first to be removed before co-operative work, the only apparent solution of the problem, can be attempted. I am not here as a socialist to discuss this problem, but as a worker in the field, noting something of the drift, and conscious in part at least of the power of organization reached through corporations. There is, to my mind, no other solution.

Those standing between the producer and the consumer must be eliminated. If the individual can work out his problem, well and good. A few have done this by making their products so attractive that consumers break from the regular channels of trade and touch elbows direct with the producer. Not every man can do this. It cannot be forced but must come as a result of keen appreciation of the consumer's fancy and of how to satisfy the same. The great majority must, of necessity, turn their surplus into regular channels unless some other is provided at their doors. The most direct and effective pathway lies through some co-operative movement, but this is possible only when, as in the case of the so-called trusts, individual identity is merged in the corporate body.

In California, when the burden became too oppressive, the fruit growers came together and formed their association, turning their products into the hands of one man, under whose direction sorting, packing and marketing were completed, the grower being known only by number. The result has been prosperity and enthusiasm for increased production. In my own city of 15,000, there are 40 or more teams delivering milk every day. On the street where I reside, within a distance of less than ½ mile, 15 teams drive

daily. Could this milk be delivered at one station, 8, or at most 10, teams would cover the city easily. The volume somewhat exceeds 5,000 quarts daily, and farmers drive from 2 to 6 miles, those farthest away starting at 4 A.M., or earlier. To suggest uniting this product and its distribution by one representative of the producers would be a hazardous step. There's a good-sized chip on the shoulder of the average American farmer that we call "personal liberty" or "the right to do as I please under the law." This chip is the rock of offense. Other industrial interests have united to cut expenses, why should not the farmer? If the milkmen of my city should unite, as they might, and through an agent and his assistants deliver the daily supply, the net saving would exceed 1 cent per quart, $50 per day, while every milk man would save from five to nine hours daily, himself and horse, beside the wear and tear of vehicles, harnesses, utensils, etc. If railroads must unite to cut expenses of administration, if corporations must merge that more economy be enforced, if all the business of this nation is to be conducted through union of forces, how long can the producer of farm products contend with his neighbor in the disposal of the same? The trend of the age is towards concentration, the saving made possible by uniting. So long as farmers refuse to follow this path, so long will they, as individuals, be at the mercy of contending forces.

There is a tremendous loss yearly to the individual resulting from failure to so organize his work as to make the most of every hour. The successful manufacturer feels the necessity for this, and in every way possible seeks to perfect some system to reduce cost of manufacturing.

Some day this will extend to the farm, and then we will realize the loss because of disorganized methods. We lose for lack of a system of rotation, because acres under the plow are not contiguous, in the waste resulting from method of handling dressing, from failure to keep daily record of production per cow, or test for per cent of fat. We lose by misapplication of plant food as well as by failure to apply in right quantities or at the right time. We lose by not conserving moisture in the soil, — a good dust mulch is a

safeguard against drought, yet we fail to realize its saving power. More than all do we lose because of failure to systematize our work, or by reason of clinging to old-time methods and practices obsolete under present existing conditions. All these problems are in our hands to be corrected, in harmony with the demands of 1912, and by correcting these our share in the consumer's dollar will increase because cost of production has been reduced. It is 1912 which confronts us, and what was good enough for our fathers is not good enough for us. What was good enough in 1911 is not enough. It is time we faced forward, towards the hills whence cometh our strength, got out of the ruts, got away from all bad practices and started right for future results.

England, the United States and the rest of the world should turn to Denmark as an object lesson. Denmark can teach the whole world the benefits of co-operation, and the value of scientific education as applied to land. It is a small country, and some time back it was confronted with an agricultural crisis which would have been fatal had it not been met in the right way. Then was evolved and subsequently perfected a great co-operative system, under which Denmark attained a remarkable prosperity, considering its size and climate. One has but to look at its exports of agricultural products — eggs, butter, bacon, pork, etc. — to realize this. It is pre-eminently a country of the small man. There are only a few more than 800 holdings of over 540 acres each as against 116,000 odd holdings of 7¼ acres or under each.

There is at Freehold, N. J., a marked illustration of what practical co-operation will do, the business the past year amounting to $1,499,500, all this upon a capital stock of $74,285, representing 1,049 members, the shares having a par value of $5. Twenty-five loading stations are operated, all controlled by the head office through telephonic communication.

We have in Maine a marked illustration in the Houlton grange store, established in 1895 simply for the purchase of fertilizer, grain and groceries by the members. In 1900 the store was kept open every Saturday afternoon. It had goods

then to the amount of $492.57, — cash $103 and liabilities $569.56, or net profit of $32.90. In 1911 the business exceeded $200,000, with a large balance to the good, complete equipment and a thoroughly organized business, the net increase, with all bills paid, being in excess of $25,000.

These isolated cases indicate what might be general, to the greater profit of the individual producer, affording a direct avenue for the disposal of his supplies with cost of same minimized.

Before a radical change can come and new conditions be established we must fix a standard of quality and a type of product most economical for producer and consumer. "What pleases the eye satisfies the palate," says another, but we must get behind the mere show of products in some attractive form and study the problem of producing in like type a larger volume.

The half-peck, peck and half-bushel carton is sure to come into general use with growers, affording a neat and attractive, as well as convenient, method of disposing of farm crops. That these may satisfy there must come a critical grading to size, and this will necessitate a study of production that greater uniformity may be insured. The potato growers of Aroostook have found by narrowing space between rows, and in the rows, increasing the seed supply per acre from 12 to 17 bushels and using uniform, medium-sized seed, that the overgrown specimens disappear. If the great restaurants of Boston pay an increased price for graded potatoes it is because they are more economical, and if that be true with them, it surely soon will be with individuals. What is true with potatoes holds with all farm products. The neatness and attractiveness of the package determines demand and price. The day has gone for the slovenly cart and unkempt driver to find a place except through the commission house or wholesale dealer. We have entered upon an era where the æsthetics are to be counted necessities, not luxuries, and buyers will more and more be influenced by the attractiveness of the package and its contents. It is not to be clean milk alone, but clean vegetables; not alone graded apples, so many to the box, but graded potatoes, beets, carrots, etc., to

the end of the chapter; and in this path lies one approach to the consumer's door.

To reach this a campaign of education will be necessary to fix the lesson and make certain the benefits of organized efforts in disposal of farm products. Confidence is a plant of slow growth, but its cultivation is to-day one of the necessities. When the time comes that positive steps are taken in co-operative work additional benefits will be realized. The farmer is a buyer as well as a seller, and to touch directly the base of supplies and lowest cost prices necessitates the same organized movement as in selling. Almost limitless is the field suggested; yet it may be occupied by the farmers of any given locality with certainty of financial returns to every one. Are we ready for the forward movement?

The answer must be *No,* for New England farmers have not yet felt the force of adverse circumstances sufficiently to awaken to the necessity for action and put behind them their personal liberty. Here and there the seed may be sown, and local fruit or produce associations formed and made effective. Beyond this there will first be demanded the frank, open discussion of the problem as it relates to the individual man or locality, until sympathy is created, interest aroused and definite action insured.

But, says one, you are introducing complicated problems, and it is true; but tell me, friends, which way you can face to-day and not meet others as complex. We lose because we take counsel with our fears. I want to press home one thought right here, that I care not how complex or multiplied these problems may be, there is one fact to which we must cling. That man who thinks as he works will solve every problem. No man has so good an opportunity for consecutive, conservative thought as the farmer. If, as he toils, he will but think, the way will open for intelligent action and necessary steps will be taken.

What was true of California has since been demonstrated true of Oregon and Washington; of the fruit growers of Delaware, Virginia, Georgia or Florida and the truck farmers of the south. Out of their very necessities they were forced to unite for protection, and in thus shipping, diverting, han-

dling and selling their own products, prices have been realized that were considered impossible before, and the key to a live enthusiasm has been found. Think you this holds south of Mason and Dixon's line, but bears no relation to farm life in Massachusetts or in Maine? Think you that present conditions can long continue while individuals strive as units for what comes so easily to united forces? This industry has not always been honored by the men who till the acres. What we would have is one thing; what we must have may be quite another. If we are to realize a fair share of the consumer's dollar, individual methods and long-continued practices must be cast one side, and the farmers of a community or section be organized for mutual protection. Relief can come in no other way. You may curb the oppression of big corporations, but you cannot legislate them out of business. Organization must meet organization, and individual conceptions, the outgrowth of the years, yield to methods employed by successful bodies to-day. The problem is not what it was, or is, but what *is to be,* and for this we must prepare. In May, 1911, 9 neighbors in one of our hill towns of Maine met and organized a Fruit Growers' Association, and elected one of the number agent, the result being that while all about apple growers have sold their crop this year for $1.50 to $1.75 per barrel, this agent has returned to these members from $2.45 to $2.85 net per barrel for their shipments. More than this, the uniform grade of the pack is so good that buyers are calling for more. There is no patent on this movement. It is as applicable in Barre or Blandford, on the cape or west of the Berkshires, as among the hills of Oxford County, in Maine. One dollar per barrel more than their neighbors are getting naturally satisfies, and the influence of united effort is not overlooked. Here is the key to the solution of the problem. Through organization you can reach the consumers direct, and that may be large or small. So strong is my faith, so certain am I that good results will follow, that I want to urge that complaints cease, and that here and there a circle of influence be formed to take over, sort, pack, handle and dispose of the product of individual farms. Had the apple growers

of the town, where I am working out some problems on the land, come together this year they would to-day have been richer by $25,000. Instead, as glib agents pictured the tremendous crops and glut of fruit, a great many rushed to sell as best they could. The chief obstacle in the way of this movement for protection lies in the necessity for the complete surrender of individuality, in handling or disposing of any product, and the merging of each grower's product with every other. In California one large grower joined the association, but insisted that his packages of fruit should carry his name in addition to that of the association. The result was a regular cut in price for his goods, simply because the association was known and the individual not known.

Co-operation means only the union of those of like interests that more effective results may obtain in meeting adverse interests. If individuals feel the press of united influence the lesson is to organize, and this is co-operation.

The fundamental purpose in all these movements must be to insure more equitable returns for the commodity produced. For co-operation to be possible there must be a common need recognized, a thorough organization perfected and incorporated, and funds provided, not for revenue to the members, but for effecting certain business results. If the producer is to minimize the waste between himself and the consumer there must be rigidity in the contract holding each member to the articles of incorporation. The failure, all along the line, of like movements is to be explained by the go-as-you-please system of organizing seen in nearly every case. Something more is now demanded if permanent success is to be made possible.

There is another step to be emphasized. Justice will not be approached until in every village, town and city public market places are established at convenient centers, where the grower may display his goods and meet the consumer face to face. The immediate effect of such market places would be manifold: —

First, they would insure the grower a better price for the commodity.

Second, they would insure a closer grade and pack and choicer quality.

Third, they would educate consumers to the superiority of fresh-grown farm products, and a critical selection of the same.

Fourth, they would bring producer and consumer face to face and establish friendly relations.

Fifth, they would increase consumption of the most healthful food known.

Sixth, they would inevitably inspire, on the part of the growers, a determination to improve in quality and increase in quantity the crops thus sold.

Seventh, they would lead to a specialization along lines best adapted to the farm and most in demand in the market place.

It is true we have been soil robbers for nearly three hundred years. It is true we have not considered the problem of conservation of soil fertility. It is true that we could, by a very simple process, raise the volume of protection per acre or per animal. The marked illustrations standing so boldly in the foreground attest the truth of all this. It is also true that New England agriculture waits a stirring of the waters which will result in a determined forward movement. That day will come, that hour will strike, that enthusiasm for agriculture will be realized when growers of farm products, the real producers of the wealth of the nation, stand united to demand a fair share of the consumers' dollar, prepared to guarantee the quality of every product sold. Out of these scattered organizations will come larger, until Greek will meet Greek; the quickening impulse born of honest desire to excel will be felt on our hills and up and down our valleys, and the rejuvenation of New England farm lands will become a certainty, with fertility conserved, crop capacity increased, and prosperity insured to the honest tillers of the soil.

No discussion of this subject can be complete which includes only the financial issues. Complex as are these there is a moral influence more far-reaching. It is not our

duty to treat superficial symptoms alone; we must also treat those deep-seated.

The kind of citizenship this nation demands to-day cannot be built solely upon commercial balances. The great fact meets us that by the system prevailing, enervating work is increasing and energizing work diminishing. The commercial problem must first be solved and justice insured the producer of the food of support, but with this there goes the demand for the arousing of the mental powers of workers everywhere. As farm labor drops to the level of the largely automatic labor of the shop, ambition — the key to progress — dies. Improved machinery, multiplied helps, misdirected national or State aid tends to automatic work. Multiply the numbers of those who toil but do not think and you rapidly increase the dangers and greatly augment the difficulties. Not only the producer's commercial rights are in the balance but his manhood, — that which alone can be made supreme by thought and investigation. First of all there is demanded the removal of the conditions which prevent the growth of enthusiastic research in agricultural work, and the establishment of the *one incentive* necessary to turn the current back from town to country, — the fixing of the rights of the producer in the consumer's dollar, and the establishment of the spirit of individual investigation.

Behind all this there rises the greater problem of the security and stability of our form of government now rudely shaken through the breaking down of habits of industry, frugality and independence. If this nation is to endure it must be through the sober, consecutive, patriotic life of the country made active for service.

"The drift of country population to the towns and cities, with their many amusements, indulgences of vices and seemingly higher wages," said Rider Haggard, "is sapping the strength of not only the English but of every white race. It is true that higher wages are to be obtained in the towns by the altogether fit and strong, but on the other hand how many utterly fail and end with their families in complete misery? There certainly is not employment for everybody, and the surroundings are far from healthful.

"This flocking to the towns means the ultimate destruction of the white races if it continues unchecked. We see it now turning the race into a set of neurotic creatures, unfit, at any rate in the second or third generation, to face the realities of existence. It is filling the poorhouses, the asylums and the hospitals. I say, Heaven help the people who mainly dwell in great cities without access to the land. To remain great a people must be rooted in the land. That is why all wise statesmen, all people who can think and see things in their true proportions should endeavor at any cost to preserve or recreate a large and healthy rural population.

"In my opinion this is the most important question of our age. The flocking of the land-born to the city has always been preliminary to the destruction of nations.

"This sucking power of the towns," declared Rider Haggard in conclusion, "is a permanent problem confronting civilization. It was so in Rome and it is so to-day. There is no stability of character to be found in the town-dweller. He is easily carried away by his feelings. We must look to the dwellers on the land for that fixity of character which a country needs to remain great."

Accepting this conclusion what become the obvious duties of those interested directly in rural betterments? To my mind this wave of hypercriticism against ennobling efforts, and this overmastering spirit of indifference to the higher and enduring issues of life, constitute the greatest barrier to true progress, and indicate the specific line of work for the true friend of the home farm and the farm home. Labor when organized upon the basis of might destroys; when united for mutual helpfulness it builds up. In the one case reason is dethroned, in the other it is made supreme.

Not in criticism, not in denying, not in strengthening any of the bonds of unthinking service, but in uniting to quicken manly endeavor, stimulate individual activity, arouse the spirit of mutual helpfulness and promote the consciousness of the true dignity of labor when directed by intelligent thought, is the mission for the leaders of agricultural progress to-day.

Laboring with this as the one goal for all endeavor, pro-

ducer and consumer will be brought together, the rights of each established, and our institutions made secure, because faith will inspire, hope quicken and brotherly love sweeten the hours of toil and strengthen the spirit of devotion to the highest conception of loyal American manhood.

Secretary Ellsworth. Mr. Chairman, I would like to add a word. I was at a banquet at the Waldorf Astoria last fall, given by the president of a western railroad. President Brown of the New York Central Railroad gave a very exhaustive and wonderfully written paper that he had prepared, to show just how production was not keeping up with the increased population. Following that, Dr. H. W. Wiley said, "That is all right, Mr. President, but when you pay us for increased production we will increase it. We have millions of acres of land in the United States that isn't worked because it doesn't pay to work it." It isn't very often that you have two after-dinner speakers contradicting each other at the same place, but that was a fact there. Dr. Wiley hit the nail on the head. He said, "A farmer, having steers, sells them for 9 cents a pound, and for the steak he must pay $0.75 or $1.50 a pound on the table." The middleman has to be supported. It is necessary to have some middlemen, but the large cities have 10-story blocks full of people who are living on the farmers. How is that going to be changed? That is the problem, and the most excellent paper by Dr. Twitchell gives us the entering wedge. It is largely by co-operation. And how can you get the people to co-operate? They will do it when they are obliged to. We are very independent people. He referred to the Oregon fruit growers. I have been there on two different occasions. I visited the Hood River Apple Growers' Association this last year, and their system has made for those people a very handsome profit. Before that system was adopted they were helpless. They couldn't sell their products to advantage. They were growing apples 3,000 miles from the principal markets. The shippers and the sellers were taking all there was in it. They organized an association. They put $50,000 into the association. About 80 per cent of all the

growers belong to that association. They built a storage plant that cost $40,000. And not only do they send their apples there, but they are also buyers and sellers of supplies at wholesale rates and small profits. I saw in one storage room a large amount of arsenate of lead. They pack a uniform package, guaranteeing that every apple will be as represented. They have won a reputation, and people buy their product. We have better apples right here in New England, but we haven't packed them properly and haven't labeled them as they should be. The Oregon apples are packed right and labeled right, and, on account of their distance from the market, they are obliged to conduct their business in that way. They did what they claimed, and they secured a market, which compelled our people to form a New England association, which is the Fruit Growers', and which held a show in Boston, the results of which have begun to show already. There have been many apples sold this year, which have retailed in the Boston and Worcester market for 60 cents a dozen, — grown right here in Worcester County.

Mr. Harwood. When I was a boy in high school Dr. Fisher, of Fitchburg, advanced exactly the same thing about fruit — picking off undesirable fruit, packing properly, and getting a good price for it — that is practiced by up-to-date fruit growers to-day. People listened, but few adopted this advice. The condition in the northwest was such that fruit growers had to adopt proper methods in order to get the market, and the fact that they have done so has now forced Massachusetts fruit growers to do likewise. Dr. Twitchell speaks of Delaware and other places having fallen into line, but Massachusetts has also fallen into line, — Massachusetts and New England, — and the last fruit show in Boston was an eye opener. There were Massachusetts apples there that later sold for $5 a box. Some of these apples went to the New York show, and they were the most attractive lot of apples there. People passed around the hall, and, coming last to the New England exhibit, they had nothing but the highest praise for it.

The doctor speaks of uniformity. "Uniformity" wasn't confined to the apples in the New England exhibit at New

York, for potatoes, onions, corn and market-garden products were just as uniform, and they were not oversized, as were some of the western products. The Boston Market Gardeners' Association had an exhibit put up by Mr. H. F. Hall, a practical market-gardener, member and president of the association. I believe that that was the best exhibit of vegetables that was ever shown anywhere, and of the thousands of people that passed every one said that it was the handsomest lot of vegetables they had ever seen.

We didn't have a dollar to spend for embellishment. We had to depend on the product itself. We got the best apples and the best vegetables to be had, and arranged them in the most attractive manner. We put a row of red apples, then a row of green, another of red and another of green, with a great block of red in the center, and so on. The vegetables ran diagonally across the exhibit, and in the center was parsley, a beautiful green, then a row of carrots, yellow, then radishes, red, etc. We got beauty, uniformity and quality out of that exhibit, and it was greatly admired, especially by the women, who always appreciate those things.

Mr. Walter D. Ross exhibited some Sheffield field corn, a variety which holds the world's record for production of flint corn. The management awarded Mr. Ross a special prize for that corn. The thing I want to emphasize now is that Massachusetts has the goods. All we have got to do is to put them up properly.

The time has arrived for the dairymen of Barre and this vicinity to act if they want to get in on this Dr. North proposition. I want them to get together and agree to put up the kind of milk he advocates, and I have assurances, at least, that there are one or two parties in Boston who are willing to handle the milk, if the market can be established here. A producer of certified milk told me yesterday that just as soon as this thing was in operation his business was gone. Dr. North, I think, showed clearly why that is so. It is the same idea which Dr. Twitchell suggests here to-day, — economy in handling. Such milk would probably have to sell at 12 cents a quart, but it would kill all 15-cent milk, because the quality is the same.

Dr. Twitchell. Why does New York call for an oval potato and Boston for a round one? Why does New York call for a white egg and Boston for a brown one? You say it is fancy. It may be; but they want a uniform type in both cases. Why should we fight against fancy? Why not cater to it? That is the thing to do. And it is going to be done. What is suggested in the milk question is applicable all along the line, but it is not going to be reached through individual effort. There must be a getting together in the handling of the product so that expenses may be reduced. Why were the men in Oregon obliged to go into the association? Because the association was known. Why was the association obliged to put up apples of uniform grade? Because the association's life depended on it. The association could do what no man could do, and, having started out to do it, it had to do it to maintain itself. We have the soil and climate here to grow the choicest apples. The New England soil and climate give a quality of product that cannot be produced on soft bottom lands. We must take advantage of what nature has provided and put ourselves in line to cut out the men who stand between, so that 65 cents out of $1 will get into our pockets.

Mr. Ellsworth. You spoke of that association, the Oxford County Bears. They are getting more for their apples than the individuals?

Dr. Twitchell. Yes.

Mr. Ellsworth. Isn't it a fact, that there are more of those people who will join your association another year, after they see the object?

Dr. Twitchell. They have already applied.

Mr. Ellsworth. That was the result at Hood River. When you get an association started and outsiders see the profit there is, they will join.

Dr. Twitchell. The life of such an association depends on maintaining the evenness and regularity of its products. The individual may slip some poor apples into the barrel and sell them without his name, and he stands a chance next year to sell to somebody else, but the association, with its name upon the package, must maintain the character and

dignity of the association, and people are willing to pay for it. The middlemen are multiplying even in our towns and villages. Every man meets it when he goes into town where there is a market. That is the situation that confronts us, and we must meet it by some method by which we may cut loose and reach the consumer direct.

Mr. Ellsworth. Aside from Mr. Harwood and myself there is another gentleman here who was at that New York show, Mr. Newkirk of Easthampton. Perhaps he saw something we didn't. Mr. Newkirk, a member of the Board, was there as an observer, and wasn't otherwise interested in the arrangements, so had the time to look around and compare, and he might say a word about that little show.

Mr. Frank P. Newkirk. Mr. Chairman and Gentlemen: Of all the association exhibits that I ever attended this beat them all, and little Massachusetts did it beautifully. When the people came along there, and looked at that beautiful array of apples and vegetables, they just stopped. There wasn't a place in the whole arena that was so fully peopled as in front of the New England stand. I stood back from the rail a little way, and a lady and gentleman came along and proceeded to admire the "artificial fruit and vegetables." I picked up one of those cucumbers and handed it to that gentleman, who was heartily surprised to find that it was real.

Now as regards the apples. Those that we had in the exhibit were so uniform in size that they were simply beautiful. I had quite a talk with the packer from the Hood River district, and his opinion was that we in Massachusetts do not realize our opportunity. All we need to do is to clean, grade and pack our fruit properly in order to practically monopolize the best eastern markets.

All we had in our exhibit was just the fruits and vegetables. We didn't have it festooned and all lighted by electricity and beautifully decorated, as a good many of them did. We just had the goods, and the goods drew the people. Gentlemen, you have the best land right here. I am not much of a farmer, but if I had the room and were inclined to horticulture, I would go into the apple business. There

is money in it, if you take care of your harvest and do it up in the right shape.

Mr. J. J. Irwin. I wonder if the public appreciate what our secretary has done for this State? I certainly hope they will. He has started a movement which has gone around the world. The people out west come back here and look at the progress in the State of Massachusetts with amazement. Who is responsible for it? The secretary of our Board. I hope that the people in this State will begin to think and to appreciate what he has done during the past several years.

Mrs. John F. Adams (West Tisbury). I was very much interested in the paper this morning. There is no doubt but what the consumer will be perfectly agreeable to everything done in a wholesale manner, but supposing in our town there are 5 milkmen, and some day they decide to remove the chips from their shoulders and unite. They go into town; they decide which one shall carry the milk; he goes to a certain consumer, and the consumer, not liking him personally, refuses to buy from him. In a town about 8 miles from us the grocery people have combined. They are selling just as good goods just as cheap as ever. Here is a family, who spends a great deal of money for groceries. They refuse to trade with this combination, declining to be told that they "must buy from a certain man." I personally know such a family, and they say they have no fault to find except this very reason. Now wouldn't it be a good idea to take some of this money we are going to save by co-operation and start a kindergarten to train the public to appreciate some things? We have this all planned out, and we decide just what we are going to do. Will the public appreciate it?

Mr. H. M. Howard (West Newton). Mr. Chairman, I was very much interested in Dr. Twitchell's paper, especially in the comparison of prices, — the price paid the farmer in a wholesale district and the price paid the retailer in a consumer's district. There is altogether too great a difference between the amount received by the farmer and the amount paid by the consumer, but you must remember that the retailer takes an immense chance, and a good many times

he sells on six, eight, twelve and sixteen months' time, and he must cover himself. There are a great many people in my city who I know do not pay the market man oftener than once a year. There should be a big difference there between the amount the consumer pays and the amount the farmer receives. Where the sales are for cash, or where the bills are settled within one week, there is a smaller difference between what the farmer receives and what the consumer pays. Take it, for instance, in the price of lettuce, where 18 heads of lettuce are selling for 35 cents in a wholesale way, the consumer is buying 3 heads of lettuce for 10 cents. In most every case where they pay their bills promptly or buy for cash, in large cities, they buy on a very small margin.

In regard to the public market. I think it is a wonderfully good thing for both farmer and consumer. Every producer, every farmer, goes to market on certain days, and if there is a public marketplace in every city or town for the farmer's use, and the consumers can go there and buy, they can buy pretty close, and the farmer gets very close to the consumer's dollar. The temptation, then, is for the commission man and the dealer to try to do the farmer up by forcing him to get out of the market at a certain time in the day and give them the opportunity to do business the rest of the day. That scheme was tried in Boston, — to drive the farmers out of South Market Street and out of State Street at 10 o'clock in the morning, — but it didn't work. The farmers had an association, the Boston Market Gardeners' Association, and they defeated that attempt. We have got to have associations in order to protect ourselves, or we will never do anything as farmers. I should like to see in every town and in every village a public market some day in the week; in the smaller places one or two days in the week is enough.

Mr. H. A. Turner (Norwell). Mr. Chairman, I have been very much interested in this address of Dr. Twitchell, and I want to ask him one question. In our locality our leading industry just now is the poultry business, and it is very nice for the poultry dealer to have the middleman come in with his team and pick up the fowls and pay the

cash. I want to ask him if he thinks that there is any better way for the poultry man to do than to keep on in that way, — whether an association would benefit the poultry men by establishing a market in the city and hiring some one to take charge of it, or in what way could they be benefited?

Dr. TWITCHELL. It is pretty difficult for an outsider to understand all the details. I suggested small, local organizations, and with a purpose, — that we might feel the way for the future. Those organizations must be adapted to the locality and to the condition. I do believe that we have got to come to the association in the handling of the poultry product. You are paying somebody else for dressing the poultry; can you afford it? Can the middleman do it cheaper than you can yourself? Is the middleman paying you for your live stock what you could get if you shipped direct?

Mr. TURNER. There is a great difference between the price paid by him and what the consumer has to pay.

Dr. TWITCHELL. How far this difference can be obliterated through an organization is not for me to say. I couldn't answer the question, for it is something to be investigated by the workers in the immediate locality. If you are not getting your share of the consumer's dollar for the product, how can that be remedied? It must be remedied by taking the business more largely into your own hands. How can that be done? Through combined effort. They can dress poultry probably in the dressing place in Boston cheaper than an individual could dress them. Now could you, by an organization, employ a man to dress poultry as cheap as they can? The whole problem is simply suggestive, it seems to me, but it is a step I believe we have got to take.

Mr. ELLSWORTH. Mr. Chairman, it gives me great pleasure to move a vote of thanks to the Worcester West Agricultural Society, the people of Barre, and to Mr. Smith, the delegate to our Board of Agriculture, for the splendid welcome and courteous treatment that they have extended to us. It has made this meeting one of the best, and I want to add to this motion that we extend our thanks, also, to the speakers who have been here and given us such splendid papers and discussions.

Motion carried unanimously. Meeting adjourned.

SUMMER FIELD MEETING

OF THE

BOARD OF AGRICULTURE

AT

CONCORD.

July 25, 1911.

SUMMER FIELD MEETING OF THE BOARD AT CONCORD.

The summer field meeting of the Board was held at Concord on July 25, 1911. The day was pleasant and a good number were in attendance. In the morning, at 9 o'clock, a visit was made to the historic spots of Concord, including the monument of Ephraim Bull, the originator of the Concord grape. At the asparagus branch of the Massachusetts Agricultural Experiment Station, at 10.30 o'clock, Mr. Charles J. Prescott, in charge of asparagus investigations, gave a lecture on growing the crop and an explanation of the experiments being carried on.

In the afternoon Dr. H. J. Wheeler, director of the Rhode Island Agricultural Experiment Station, delivered an address on alfalfa growing.

BULLETINS

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THE GROWING AND MARKETING OF SQUASHES, MELONS AND CUCUMBERS.[1]

BY HENRY M. HOWARD, DIX FARM, WEST NEWTON, MASS.

The cultivation of each of these crops is most easily understood and performed. The preparation of the soil is so easy and the labor of cultivating and harvesting so light that they have been called the lazy man's crops. But in order to get a large yield of high quality, and make a big profit, a grower is required who is able to surmount every difficulty.

In general the preparation of the soil would be the same for each of these crops. Manure is applied broadcast, at the rate of from 8 to 10 cords per acre, and plowed in about 6 inches deep. Additional manure or fertilizer is used in the hill. As soon as the manure is plowed in, harrow and level the surface, and continue to harrow and level at intervals of a week until ready to plant the crop, the latter part of May or the first part of June.

Squashes.

The growing of squashes can easily be made more profitable than the raising of corn or potatoes. There is considerable outlay connected with starting in the squash business. It is necessary to have a good storage plant, well built and heated, but this plant requires very little repair, and there is no great shrinkage in value. A good squash house is double-walled, rat proof and plastered on the inside. The shelves are made 6 or 7 feet wide and 2½ feet apart, one above another. A walk 2 feet wide is left all round the wall and between the tiers of shelves. The heating may be by a coal stove or a hot-water heating system, having the heating pipes located on the walls and near the floor. The ventilation should be by windows on the side walls and gable ends.

A crop of squashes will vary from 7 to 10 tons to the acre. Some varieties are much heavier croppers than others. The Bay State has yielded 12 tons per acre. The price per ton varies from year to year. There is usually a good market some time each year at $30 per ton, and often at $40 to $50. One year not long ago a few were sold at $4 and $5 a barrel. Considering the average crop of squashes, and how great a yield of some companion crop may be secured, the growing and storing of winter squashes look quite attractive.

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[1] Crop report for May, 1911.

The hills for squashes should be 10 by 10 feet or 12 by 12 feet apart, according to the soil and the variety grown. At the greater distance the vines will often more than cover the ground and pile up. Where manuring in the hill alone dig in a bushel of manure to the hill, about 1 foot deep and in a circle 2 feet in diameter. If manured broadcast, as above suggested, a single forkful of manure or a large handful of fertilizer dug into the hill will be enough. Plant five or six seeds in a heel track and cover $1\frac{1}{2}$ inches deep. Bunching the seeds does no harm and the after-care is made easier than if they are scattered.

The young plants should be up in five to seven days, and should be dusted at once with a mixture of plaster, tobacco dust and Paris green, a teaspoonful of Paris green to two quarts of plaster and two quarts of tobacco dust. Often the flea beetle is on the plants and eating before the farmer knows that the plants are up. The flea beetle is easy to subdue, but the striped beetle is more persistent, and must be attended to several times, until his season is past. It is extremely important to dust with poison and plaster as soon as possible after a rain, as the striped beetle eats very much more rapidly when the vines are clean and soft.

A duster may be made from a two-pound baking powder tin by punching holes in the bottom, three-fourths of an inch apart, with an awl or nail. A little experience will show how much poison dust to put in the can at a time, but it should never be filled full. Put the cover on tight. Put as many men or boys at the dusting job as possible, and get the dust on while the plants are moist. These dusters are particularly useful to put tobacco dust on peas, carrots and lettuce when attacked by the green fly.

By planting squashes as late as the 10th to 12th of June, trouble with the black bug can be largely avoided. The bug is not often troublesome, but when he is he may be trapped under shingles placed on each side of the plant and inspected early every morning. Picking off the bugs and their eggs and dropping them into a pail of kerosene is the best known means of dealing with this insect.

For very early summer squash or early marrows the seed is planted under glass in hotbed or greenhouse, and transplanted into $5\frac{1}{2}$ or 8 inch pots, two plants to a pot; they are grown in the pots, with glass protection, for about three weeks, and then hardened off to set in the field. Plant the seed for these early squashes from April 1 to April 15, and they will be ready to set in the field from May 15 to May 20. The summer squashes are set in the field $3\frac{1}{2}$ by 6 feet, and the marrows 6 by 6 feet or 6 by 9 feet.

The soil for early summer squashes should be manured heavily for spinach or radishes, either one of which will be off in time to set the summer squash. Furrows are made every 6 feet and potted squash plants removed and set every $3\frac{1}{2}$ to 4 feet. The cultivation of summer squashes is very intensive. A plow is used to turn a furrow away from each side of the row and then turn the soil right back to it, not

allowing any time for it to dry out. The plow loosens up the soil near the plants, and new roots at once make use of the loose soil. After-cultivation is given about once a week with the cultivator until July 10, at which time the vines should cover the ground. Summer squash well repays for irrigation and intensive cultivation, and will easily return 25 cents per hill. Some seasons there has been a wilt disease on summer squash, and vines apparently vigorous wilt and dry up in four or five days, no amount of care or attention being of any avail. The disease does not attack the plants until some fruit has been produced. Varieties to plant are Giant Crookneck and Mammoth White Scallop. The cultivation of other kinds of squashes will vary according to the system of planting, but it can all be done with the plow, harrow and cultivator. When planted with a crop of peas or beans some work will have to be done with the hoe. Thinning the hills to three plants should be done when the plants are 4 or 5 inches high, at the same time pulling a little soil up around the plants that are left.

Squashes are easily hurt in harvesting, being cut or bruised in handling. The summer squashes and marrows are usually handled in boxes or crates, and if put up carefully present a very attractive appearance. They are sold by the dozen, hundred or barrel. Winter squashes are usually stored in the fall and sold by the hundredweight or by the barrel during the winter. Carefully harvest the squashes, without cutting or bruising, and place in piles in the field, making one row of piles to every three rows of plants. When all are harvested they may remain in the piles a few days, until they dry out somewhat. They should be carted to the storage house in spring wagons, and mats or blankets used to prevent the squashes being injured in the wagons. As the squashes are put away in the storage house they should be sorted, the larger ones being placed on the lower shelves near the walks. The smallest and most immature ones should be placed on the highest shelf. There is little trouble involved in keeping squashes if they are carefully harvested, handled and stored. The house must have proper heat and ventilation. When first filled the house should be kept open as much as possible, as unless the squashes are able to give off water and dry out they will rot. As the season advances the ventilators may be closed somewhat and heat applied to keep a uniform temperature of about 50° F. There should always be a dry, clear air in the squash house, secured by proper heat and ventilation.

The marketing should begin with the best and largest squashes. A squash with a hard shell, large size and good color will start the market well. By getting the large ones off first the farmer largely reduces his chance of loss from speck or rot. As the large squashes are removed and sold those remaining should be more thinly spread on the shelves. The writer has seen squashes of the Hubbard variety kept over from one season to another, or from one September to the following September. These squashes were much lighter in weight and in color

than when put into the house, but their quality was good. They were kept in a good house where the grower paid considerable attention to heat and ventilation. Selling squashes by weight is the best way for the farmer early in the season, and by the barrel the best for him late in the season, for they lose much in weight during the winter.

Muskmelons.

Muskmelons are a crop most easily grown, and quite profitable and satisfactory when certain methods are carefully followed. Good standard varieties are Emerald Gem, Early Hackensack and Montreal Nutmeg. The soil for melons should be a sandy loam. The hills should be 4 by 6 feet apart, with several seeds in the hill, planted as soon as possible after May 10. A crop may be secured if planted as late as June 15. The hills are prepared by digging in a large forkful of manure and a large handful of fertilizer. The plants will be up in a week to ten days, and will need protection from the black flea beetle, striped beetle and cut worm. Be even more careful to watch for these pests on melons than on squashes, as melons are more tender and more easily destroyed.

The cultivation of the crop consists of one hand hoeing as soon as the plants are up, then horse cultivation until the vines begin to cover the ground, and finally another careful hand hoeing. After the vines nearly cover the ground they should not be disturbed by cultivation, but large weeds may be pulled by hand. The melon vine does not do well if moved after once spread for a crop.

If it does well, the crop should begin to come off by the middle of August and continue for two weeks. Melons should be picked every day, and when maturing very fast twice a day, taking only those which are ripe. Pack the melons in boxes or baskets, making two or three grades, and work up a trade on what you have. Good melons will bring from $1.50 to $2.50 a box of 18 by 24 inches. A good crop will give five or more first-class melons from each hill. Some melons mature very quickly. The Emerald Gem is one of these, and it seldom fails to mature its crop before the time of the August blight. This variety has never been troubled much with the blight, and has always been satisfactory in quality and a good money maker when grown under glass or in the open.

To grow melons under glass on raised benches set the plants one in a place, a foot apart, on the back side of the bench. Remove all the soil from the front part of the bench. Train the vines to a single stem and allow only three melons to set on a vine. Support these three with netting of some kind, cloth or wire, and you will probably get the most perfect fruit you ever saw or tasted.

A crop of melons may be started in a bed, and when the vines begin to cover the ground the sashes removed and the vines allowed their own way. This crop is usually prolific, and will average more than five melons to the hill.

Another way of handling the crop is to start the plants in a hotbed or greenhouse and transplant to pots, setting the plants in the field after the first of June. By this method we have no trouble with bugs or beetles and very much better results in the way of yield. This system is adapted to market gardens, as the land can be used for an early crop of spring radish or lettuce, and then be available for the melons.

As the melons are nearing maturity out of doors it will be found profitable to set them up on shingles, glass or berry baskets to protect them from wire worms and from spotting. The richer and damper the soil the more danger there is of loss from spotting.

Cucumbers.

Cucumbers are a greenhouse crop. They are raised under glass in beds or greenhouses almost exclusively when raised at a profit. Of course many cucumbers are raised out of doors, but the season of fruiting is much shorter and the crop lighter per plant than when grown in a greenhouse. The greenhouse crops may be started at any time of year. The crop most productive of large returns will be one that is beginning to fruit in April or May. This crop will continue in fruit until August if carefully handled and protected from green fly and red spider.

There are two particular ways of training the greenhouse crop, called the string system and the trellis system. The plants for either system are raised the same way. The seed is sown thickly in a bed over a mild heat. As soon as the seed leaves are open the young plants are set over into a seed bed, about 2 inches apart each way. In a few days, three to seven, they should be set over in 5½-inch pots, one plant in each pot. The pots should be plunged level with the ground in a greenhouse, and set over mild heat in March, but need no heat if set in April. If set in a bed or frame they will need some bottom heat. It is best to water with water as hot as the hand can bear when transplanting seedlings to the bed or pots. It is best to let the pots go dry a few days before transplanting to the permanent row. This will toughen the plants, and none will be lost by breakage in handling, as they would if grown soft. Just before removing from the pots soak each thoroughly with the hose, or by dipping in a tub of water.

For the early set cucumbers the rows are prepared either the long or short way of the house, by digging out a trench 18 inches wide and about as deep, and filling in a foot of good, moist, hot horse manure, and covering with 6 inches of loam. When setting, the loam is scooped out every 16 to 30 inches and a plant set right down onto the hot manure. The soil is then drawn around the ball of roots and the rows watered with warm water. For the crop set in April or May no heat under the row is needed. A heavy coat of manure is worked in and the plants set as above described. Then some crop like radishes or beets, for greens, is sown between the rows of cucumbers. Either

of these crops can be taken from the land in addition to the cucumbers, and not hurt the cucumber crop, if done carefully, as they are out of the way in four to six weeks. The cucumbers will begin to fruit in four to six weeks from setting the plants. It takes about four weeks to raise the plants from seed.

The string system of training the vines is quite popular at present in the vicinity of Boston. The plants are set 14 to 16 inches apart, in rows 4 feet apart. They are trained to a single stem on three-ply jute string, stretched between two wires, one a small No. 18 wire, attached to the walk boards, and the other a large wire, No. 14, stretched across the house, and attached to screw-eyes in the sash bar. These two wires are about 6 feet apart, and the heavy one, directly above the row of cucumbers, is supported by the heating pipe, or by wires attached to the posts of the house. The jute strings are stretched between these wires. The training of the vine to a single stem is very simple. The vine takes to the string without much attention, and when it reaches the large horizontal wire it is trained one way over five small wires stretched between the large ones. Laterals will come out at every joint on the main stem, and each of these may be allowed to set two pickles, and then pinched back. The amount of fruit that sets on a single plant before the main stem reaches the top wire is enormous. It is claimed for this system that there is a larger set of early cucumbers than by any other system. All the wires once up are up to stay, and the string is cheap and easily removed when cleaning out a house.

The trellis system requires fewer plants, as the rows are set every 8 or 9 feet, and the plants 16 to 30 inches in the row. The plants are trained to three stems and are tied in place on the trellis. The trellis is made by setting 3-inch furring every 9 feet, at a slant of 45°, and stretching on these five No. 18 wires, or a cucumber netting, on which to train the vines. One row of furring is made to support another, and the end pieces are secured to the sash bars or heating pipe. There is much labor in getting the trellis into a house and in setting it up, and about as much more in getting it out again. The advantages of the system are these, — more chance for light on the leaf system, fewer plants to raise, and it is much easier to see the cucumbers when picking. If the rows of plants, under either system, are run the short way of the house, the heavy pickings of fruit can be more easily gathered on the wagon.

The cucumber requires an even temperature, not too wide a variation between day and night, expecially when loaded with fruit. Watering must be carefully attended to, and enough yet not too much water applied. The vines are sometimes spoiled by too heavy watering. As soon as the ground in a house is cleared of small stuff it is loosened up with forks, and then wet down and mulched with coarse manure. Care must be used not to put in manure which is giving off ammonia, as it will injure the leaves. In every path across the house a board

is laid to walk on, so as to keep the soil light and loose. A good crop of cucumbers for a house 40 feet wide would be $350 or more for every hundred feet of length.

In order to get a good set of cucumbers in a greenhouse there should be a strong colony of bees to every 150 feet of length. The beehive should be set outside the house, and near enough to it to have an entrance directly into the house and another entrance into the open. Keep the entrance into the open closed until the bees are working well in the house, and then give them the use of the entrance into the open. With two entrances the colony will be kept in a more normal condition.

Cucumbers in a greenhouse are liable to attacks from green flies and red spiders. Control the green fly by using tobacco or nicofume for smoking the house. Dispose of the red spider by the use of a spray of soap or water, or both. It is best to consult with and learn from some one who is keeping the red spider down by the use of these sprays.

Cucumbers should be harvested by cutting from the vines with a knife when they are of a diameter barely encompassed with the thumb and middle finger. Seven or eight dozen cucumbers should be enough to fill a bushel box. Cucumbers should be harvested regularly about four times a week, and if carefully done very few will become too large. The fruits should be sorted into three grades and a trade worked up for each grade.

Large numbers of hotbed sash are used for raising cucumbers, and a good crop will return $1 or more gross per sash. Manure is trenched in as above described for early greenhouse cucumbers, to supply the needed heat. The manure is put in the first week in May, and plants set one or two plants to a sash. These beds should be about 4 feet apart. The sash will be enough protection for the cucumbers, no mats being needed. The vines will soon cover the ground, and by the first of July will be bearing heavily. As soon as the vines begin to climb out of the sides of the bed the sash may be taken away and piled up. Bed cucumbers and those planted in the open are less liable to be troubled with green flies and red spiders than those in greenhouses. If any plant or hill is infested it may be well to throw a canvas over it and smoke it, or to pull up the vine and carefully remove it, so that these insects will not infest the other plants.

Cucumbers may be planted in the open from May 1 to July 1, with a fair show of getting a crop. The land should be very rich. The hills, 4 by 6 feet or 6 by 6 feet, may be prepared as for melons. The young plants need just as much care and attention as young melons. A mulch of coarse manure over the ground before the plants cover the ground will be found very beneficial. If weather conditions are favorable, a large crop may be obtained, but the season for picking will be short. It is very hard to harvest outdoor or bed cucumbers satisfactorily, as so many are missed and grow too large. The variety most commonly planted, inside or out, is the Arlington White Spine.

CABBAGE AND CAULIFLOWER AS MARKET-GARDEN AND FARM CROPS.[1]

ADAPTED FROM FARMERS' BULLETIN NO. 433 OF THE UNITED STATES DEPARTMENT OF AGRICULTURE, "CABBAGE," BY L. C. CORBETT, HORTICULTURIST, BUREAU OF PLANT INDUSTRY, — ADAPTATION BY HOWARD N. LEGATE, FIRST CLERK.

Cabbage as a Market-garden Crop.

Cabbage is a crop which is grown by every market gardener located within wagon-hauling distance of an important center of consumption. The statistics of the distribution of the cultivation of cabbage clearly indicate the fact that this is one of the important crops grown by market gardeners. The counties near each of the important centers of population of the United States are almost universally credited with a considerable acreage of cabbage, thus showing that the gardeners of these regions have given considerable attention to the production of this crop.

Soil. — The soil for cabbage must necessarily vary in different localities. In one area it may be of alluvial character, while in another it may be sedentary, and in still another it may be characteristic glacial drift. The fact that cabbage grows well in all these soils indicates its adaptation to a wide range of conditions. The main thing with cabbage is an abundant supply of immediately available plant food. Market gardeners rely chiefly upon stable manure for their supply of plant food. Fertilizers also form an important item in the expense of producing cabbage as a market-garden crop, the quantity used depending upon the quantity and character of the supply of stable manure. The fertilizers chiefly used carry a liberal percentage of available nitrogen in the form of nitrate of soda or sulphate of ammonia (often as much as 4 or 5 per cent), 6 to 8 per cent of phosphoric acid and 8 to 10 per cent of potash. As a result of the wise use of fertilizers the soils of the market-gardening zone around any city or large town rapidly improve in fertility, and the gardener is able to grow a greater variety and larger quantities of products.

In the truck-farming area a few special crops are grown on a very extensive scale, while in market-garden regions a great many crops are

[1] Crop Report for June, 1911.

grown in succession on a comparatively restricted area. Truck farming is in reality extensive market gardening, while market gardening is the most intensive form of farming. It is the practice of many market gardeners to plant coarse-growing, long-season crops far apart, and interplant one, two or even three short-season, quick-maturing crops between them; or a quick-growing, short-season crop may be planted, and between the rows a crop requiring a longer season, so

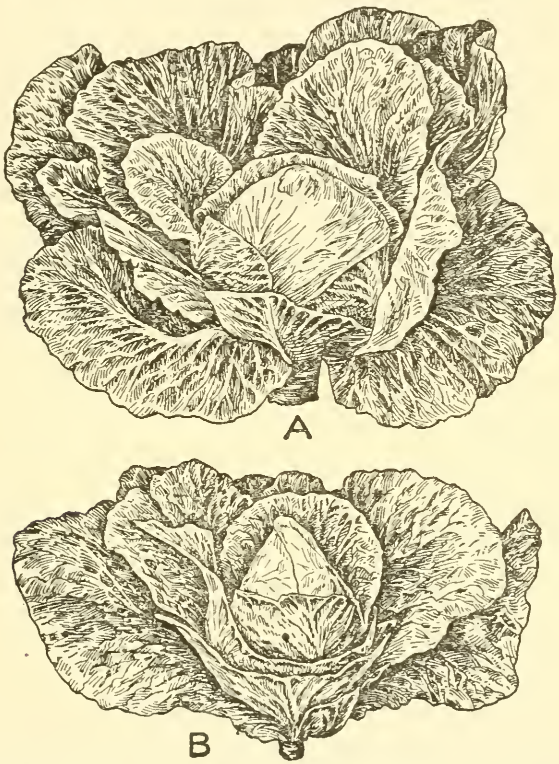


FIG. 1.—Wakefield strain of cabbage; *A*, Charleston Wakefield; *B*, Jersey Wakefield.

that as the quick-growing crop is harvested the whole area is given up to the longer-season crop. Cabbage is frequently made the basis of such a combination. Sometimes lettuce and radishes are grown between the rows of cabbage. Sometimes cabbage is planted between the rows of early beets, while late potatoes are frequently planted between the rows of early cabbage. The various combinations of such crops are too numerous to be catalogued.

Young Plants for the Market Garden. — The preparation of cabbage plants for the use of the market gardener in the north is a different matter from growing plants for use on a truck farm in the south. The market gardener at most grows only a few thousand heads. The seed

for these can be sown on an area covered by a hotbed or cold-frame sash. The extra early crop is either started in the open in September and transplanted to a cold frame as the frosty nights come on, to be protected through the winter by sash and shutters and transplanted to the open as soon as the ground can be worked in the spring, or the plants may be started in a hotbed from the first of February to the middle of March, depending upon the locality, and hardened off, as the days grow milder, by lifting the sash.

Plants grown and hardened off in this way are nearly as hardy as cold-frame wintered plants. They can with safety be transplanted to the open as soon as the condition of the soil will warrant. As a rule, hotbed-grown plants do not head as quickly as wintered plants; on the other hand, there will be fewer plants that shoot to seed. The grower will, therefore, use the plan best adapted to his cropping system, and may employ both plans in order that the peculiarities of the seasons may be most advantageously met. In some seasons the wintered plants give best results, while other seasons seem to favor the hotbed product. The use of both plans will safeguard the crop to the greatest degree.

Setting Plants in the Field. — The cabbage plants are usually set in the field in rows about 30 inches apart and about 18 inches apart in the row. For the extra early crop the Jersey Wakefield is extensively employed. A later variety may be sown in the hotbed at the same time and the plants given similar treatment, but since the late sort requires a longer season, it will form a succession with the Wakefield, enabling the gardener to maintain a continuous supply up to the time when he can utilize the crop grown from seed sown in April or May in the open, the plants of which are usually transplanted, in the latitude of New York, to open field from June 20 to July 1. This crop provides a fall supply of cabbage for the market, and when treated as a field crop is used by the sauerkraut factories and the storage houses, and is marketed in carload lots in the southern cities and towns, where extensive manufacturing enterprises are conducted.

Cultivation. — Among market gardeners it is a common expression that "cabbage should be hoed every day." Perhaps no other crop responds more quickly to good cultivation and an ample food supply. This is undoubtedly the explanation of the above-quoted expression. In cultivating cabbage the work should be frequent and thorough, but the cultivation should not be deep. The aim should be to destroy all competing weeds, and maintain a loose, friable layer of soil about 2 inches deep over the surface of the area devoted to cabbage.

Harvesting. — The early cabbage which is grown by the market gardener is cut, carefully trimmed, and marketed from his wagon or stall. The later crop, which is harvested in the fall, may not be marketed immediately, but may be stored temporarily in a cool, well-ventilated building, in which case the heads are usually cut from the stalks, carefully trimmed and stored in small bins or on shelves. If

FIG. 3. — Setting plants with machine.

FIG. 4. — Method of piling cabbage for storage over a board-covered trench, to allow ventilation, when earth is used for protection.

such facilities are not available an area on a well-drained portion of the field is prepared for the storage of the cabbage. The preparation usually consists in leveling an area wide enough to allow about five heads of cabbage to be placed, roots up, in a continuous row or belt, three in the first layer and two in the second. The outer leaves are all preserved and carefully wrapped around the heads as they are placed, after which the whole is covered with a layer of straw or marsh hay, and, as the weather increases in severity, with a slight layer of earth. In the milder portions of the country this protection is employed for the whole winter. Farther north the soil layer must be increased, and where winters are severe storage houses should be used rather than this primitive method of storing.

If the crop is to be stored on a more extensive scale it may be placed on a ventilated platform and piled in long ricks, and then covered with rye straw and a layer of earth.

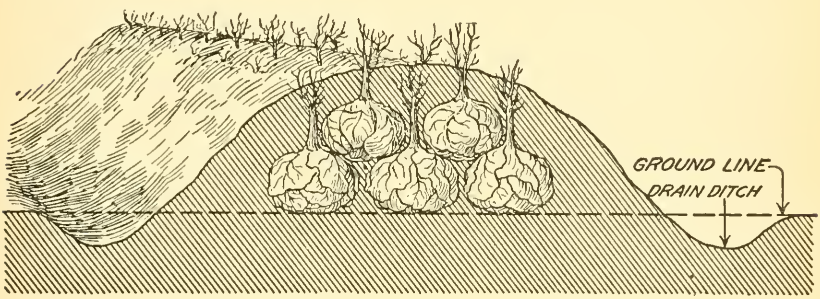


Fig. 2. — Method of storing cabbage on a small scale in the north.

Varieties. — The varieties of cabbage used by market gardeners include not only the Jersey Wakefield for extra early but a variety of the early summer or sure-head type for midseason with some of the Flat Dutch sorts as the main fall crop.

Cabbage as a Farm Crop.

Cabbage finds its most congenial habitat as a farm crop in the northern tier of States, including those bordering on the Great Lakes, the New England States, and, to a less extent, in Kentucky, Tennessee and Missouri. New York grows almost three times the acreage of any other State as a farm crop. It is this farm crop of cabbage which finds its way to the sauerkraut factories, to the cities of both the north and the south as the cool days of fall and early winter come on, and to the large storage houses distributed through New York and Wisconsin.

Soil. — The soil upon which cabbage is most extensively grown in this region is either rich alluvial bottom land or the rich prairies of the States west of New York and Pennsylvania. Cabbage is a bulky product and usually does not sell for a very high price per ton, but the

large tonnage produced per acre, and the fact that it is consumed by all classes, account very largely for the extensive acreage grown throughout the area of dense population.

Preparation of the Land. — Where grown as a farm crop cabbage is used as one of the factors in a crop rotation for the farm, and may be made to occupy a portion of the clover sod turned down in the year when clover is turned under to provide for other crops. A common rotation is to use corn, followed by oats with which clover is sown. The clover is cut one season and turned under the following spring, the area being devoted to cabbage and potatoes. The clover sod is supplemented by a heavy dressing of stable manure on the portion to be devoted to cabbage. If manure is not available the necessary supply of plant food is made up by the use of a high-grade fertilizer carrying $3\frac{1}{2}$ or 4 per cent of nitrogen, 6 or 8 per cent of phosphoric acid, and 8 or 10 per cent of potash, applied at the rate of 500 to 1,000 pounds to the acre.

Starting the Seedlings. — When cabbage is grown as a farm crop the seed bed is prepared in the open in a sheltered place. In the latitude of central New York seeds are sown in the open early in May. The young plants are kept free from weeds, and should be ready to transplant to the field about June 20.

The choice of the site for the seed bed may determine the success or failure of the whole enterprise. The vigor of the plants and their freedom from disease are factors of prime importance. The seed bed should, therefore, be located only on areas known to be free from clubroot and rot organisms. Areas where cabbage has been grown or where cabbage plants have been propagated in previous years are to be avoided, as are also manures containing cabbage refuse. The manure from stalls or pigsties where cabbage has been fed is to be avoided on account of its liability to carry clubroot and rot organisms.

Setting the Plants in the Field. — In some localities it is customary to set the plants in check rows about 30 inches apart each way, so that they can be cultivated in both directions. In other sections the plants are set in rows one way only, and are placed 18 to 24 inches apart in the row. With the large-growing late sorts, however, 30 inches between the plants in the row is not too much space. If the transplanting is to be done by hand, it will be performed by puddling the plants and setting them with a dibble. If carried on very extensively the work can, as a rule, be more economically done by utilizing one of the horsepower transplanters, in which case the plants are frequently set about 20 inches apart in the row and cultivated in one direction only. Painstaking growers, however, mark the field 30 inches apart in one direction and drive the plant-setting machine at right angles to these marks, thus enabling the setters to place the plants in check rows 30 by 36 inches apart. This plan has the advantage of placing the plants at better intervals and permits of cultivation in both directions early in the season.

As soon as the plants have been set in the field, cultivation is started and kept up with suitable implements, depending upon the size and character of the plants, until the cultivator can no longer be run between the expanded leaves of the crop. Attention from this time on is necessary to protect the crop from insect enemies, such as the cabbage worms and the aphides or "lice."

Harvesting. — At harvest time, whether the cabbage is to be shipped, carried to the sauerkraut factory or stored, a wagon provided with a very deep body is driven across the field, the heads of two rows having been cut and laid to one side in advance of the team. Men accompany the team and gather the heads which have been cut, carefully trim them and gently toss them to a person in the wagon, who loads them with equal care. Heads intended for long shipment or for storage should be very carefully handled, so as not to bruise or in any way injure them. In unloading to the car or storage house the same precautions in careful handling should be observed as in gathering from the field.

Varieties. — The varieties which may be used for field cultivation depend upon the purpose for which the cabbage is intended. If for sauerkraut or for immediate consumption, the Flat Dutch type from American-grown seed is extensively employed in the eastern part of the United States. In the irrigated section of Colorado, in the vicinity of Greeley, where cabbage is grown for sauerkraut, a variety known as Scotch Cross is almost universally grown. If the cabbage is intended for storage the Danish Ball Head, from imported seed, is almost exclusively used.

Storage. — The prerequisites for the successful storing of cabbages are: (1) carefully grown and carefully handled heads of a sort well adapted for storing; (2) storage warehouses so constructed and arranged as to prevent drip from the ceiling or roof striking the stored heads; and (3) such arrangement and control of the ventilation and temperature of the building as to prevent the condensation of moisture on the cabbage while in storage.

The Danish Ball Head, from imported seed, as has been stated, is the variety chiefly grown for storage purposes. The heads should be very carefully cut and closely trimmed, so that no loose leaves get into the storage house. In hauling cabbage from the field to the storehouse, spring wagons should be used, and the heads should be passed from hand to hand and never thrown into the wagon body. The same care should be observed in placing the heads in storage.

The general type of construction employed in commercial storage houses is that of a broad, low house with an alley sufficiently wide to admit a team and wagon through the center, and with the storage bins or shelves arranged on either side. For farm storage a house with no walks or driveways, and no waste space, is very satisfactory. At storage time the cabbages are received through the windows, and they may be discharged either through the windows or through the door.

If the heads are to be stored in bins, the bins should be narrow and not more than 16 or 18 feet from front to back, and the heads not more than 6 or 7 feet in depth in each bin. Several bins may be placed one above another in the same section by placing a waterproof flooring between the bins, so that the drip caused by decaying cabbage or other condensation cannot reach the lower bin from the one above. This plan of storage is not, in general, as satisfactory as to store the cabbage on shelves, in single layers or two or three deep on the shelves. Precautions should be taken to provide an area way between the outside wall of the building and the storage bins or shelves.

The walls of the building should be made so as to provide a dead-air space, to prevent the penetration of frost. If the walls are made of brick, two 4-inch walls could be laid up and tied by a header course, so as to provide an air space 2 or 3 inches wide between the two walls; or a solid 9-inch wall may be constructed, and either a tongued and grooved wall or a lath-and-plaster wall placed on the inside by the use of furring strips. The roof should be provided with a suitable outer covering, either of shingles, of steel or of composition, and should have an inner lining so built as to provide a dead-air space. If the inner lining is made of lumber, the boards should run parallel with the rafters rather than at right angles to them, so that condensation may flow to the eaves rather than fall from each joint. Exits for warm air should be provided by ample ventilators along the ridge, provided with dampers, which can be controlled by ropes extending to the passageways. Cold air from outside can be admitted through the apertures in the foundation by means of large terra-cotta pipes, provided with wire netting over the outer end and suitable dampers or shutters on the inside, so that the intake of air can be controlled.

The secret of success in the management of a storage warehouse is to have disease-free, well-matured, firm, carefully-handled stock grown from high-grade seed, and the storage house so constructed that the temperature can be lowered and maintained as near 34° F. as possible throughout the whole storage period. This means that the greatest care must be exercised to take advantage of cool, frosty nights which occur during the storage period, and as soon as the house is filled to keep it closed during the day and open as much as possible during the night, so as to get the benefit of the low mean temperatures. The other extreme of too low temperature should also be provided against. During protracted cold spells the temperature inside the storage house may get dangerously low. To guard against loss from freezing, oil heaters are placed at suitable intervals in the walks and alleys to maintain the temperature above the danger point.

Storage troubles are more largely the result of careless handling and bad ventilation than of diseases. Practically all of the rotting which takes place during the storage period is the result of saprophytic organisms attacking the badly handled or slightly diseased heads under bad storage conditions. Poor cultivation, bad harvesting

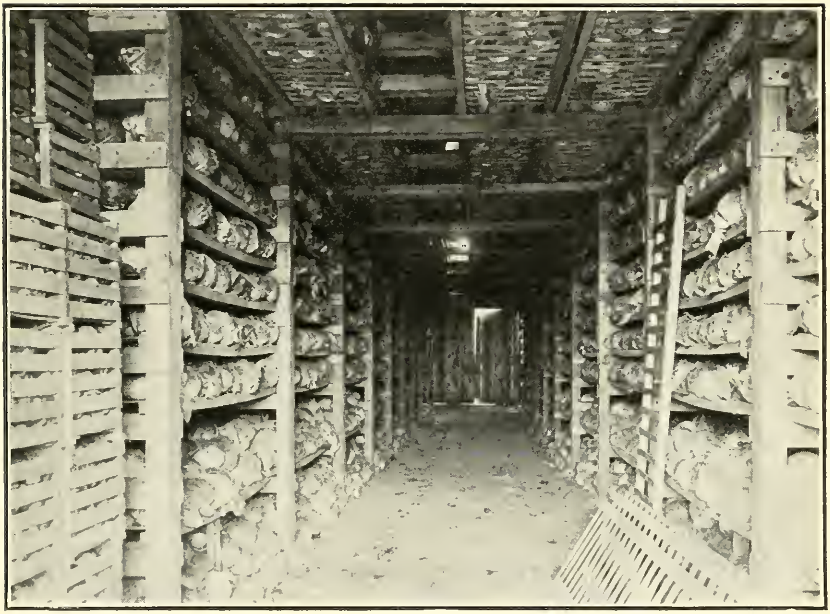


FIG. 5.—Interior arrangement of a cabbage storage house, showing method of placing the heads on the shelves.

methods, a long haul to storage, and rough handling in unloading and storing are all to be avoided if cabbage is to be kept successfully through the storage period.

Insect Enemies and Diseases.

The important enemies of the cabbage as a market-garden or farm crop are the cabbage worms, which in some instances cause considerable loss, the cabbage root maggot, and the cabbage "louse."

Cabbage Worms. — The imported cabbage worm and some other species of cabbage worms can be effectually controlled by the use of (1) Paris green at the rate of 1 pound to 50 gallons of water, or (2) arsenate of lead at the rate of 4 pounds to 50 gallons of water, sprayed on the young plants before the heads are well formed. This treatment should be repeated from time to time, as required, in order to protect the plants. Where a few plants are to be treated insect powder or pyrethrum is sometimes employed for the control of the insect by dusting it upon the plants.

Cabbage Root Maggots. — These insects sometimes cause considerable damage and are difficult to combat. Tarred paper placed about the bases of the stems prevents the flies from depositing their eggs. Injections of carbon bisulphid in the soil are effective in destroying maggots, and another good remedy is found in carbolic acid emulsion, made by dissolving 1 pound of soap in a gallon of boiling water and adding a pint of crude carbolic acid. This mixture is then diluted with thirty times its bulk of water, and poured around the bases of the plants.

The Cabbage Aphis. — Cabbage aphides or "lice" are controlled by the use of contact insecticides, such as kerosene emulsion or whale-oil soap.

Clubroot. — Among the field troubles to which the cabbage is subject none is of greater economic importance than clubroot. This disease is peculiar in its method of attack and in the way in which it perpetuates itself. The chief danger with this disease arises from the fact that either the seed bed or the field may be infected and thus contaminate the crop. There is danger, then, in purchasing plants. Infected plants purchased from a clubroot seed bed might be the means of contaminating one's cabbage land with the disease. Clubroot is a persistent malady. It will remain in the soil for five to seven years. Land so infected should not be used for cabbage, turnips, rape, mustard or any other plant of the cabbage family. The rotation of crops to the exclusion of all cabbage-like plants for a term of years is the only safe way of ridding the land of the disease. This applies with equal force to both seed bed and field. There is no satisfactory remedy known except the following "don'ts:"—

(1) Don't sow cabbage seed on soil infected with clubroot.

(2) Don't plant plants grown in a clubroot-infected seed bed.

(3) Don't use manure containing roots of cabbage infected with

clubroot on ground intended for the culture of cabbage or any of its close relatives.

(4) Don't plant cabbage on an infected field within six or seven years after the diseased crop has been harvested.

(5) Don't grow turnips, rape, mustard or other cabbage-like plants on clubroot-infected soil unless you wish to perpetuate the disease.

Cauliflower.

Cauliflower is always grown as a market-garden crop or for home use, never in any sense as a farm crop. Practically everything that has been said in regard to cabbage, as to soil, fertilizers, growing of the plants, preparation of the soil, planting and cultivation, applies with equal force to cauliflower. The only exception worthy of note is that cauliflower may be set somewhat closer in the row than cabbage, but the practice of growers varies, and many set at practically the distance apart recommended for cabbage in the foregoing.

When the head begins to form the leaves should be drawn together and fastened over the head, to keep the sunlight from it. Properly sheltered the head will present the pure white appearance so much admired in the market. If the sun is allowed to touch the heads after they have begun to grow they will first turn green and later reddish. No amount of bleaching will remove this color once it has been acquired; the only way to prevent it is to act in time. The leaves should be drawn together at the top, one at a time, overlapping each other, and fastened together by a wooden pin or skewer, thrust through the leaves, or they may be tied together with raffia or any sort of twine. Both methods are used, and with equal satisfaction, according to the preference of the grower.

Harvesting is controlled by the size of the heads and the state of the market. The stalks are cut and the leaves trimmed off close to the head. Some cauliflower comes into the market, in Massachusetts, in August, but the greater part of the crop is marketed in September and October.

Cauliflower is sometimes stored by setting in celery pits, the roots being set into the sand the same as is done with celery. Here they will increase somewhat in size, and, as no light is admitted to the pit, will not suffer in appearance. About half the leaves are cut off when cauliflower is stored in this manner. Sold in midwinter or later they often bring very high prices, and this method of storing is usually so profitable that it is surprising that it is not practiced to a greater extent than is the case.

There is no mystery about the growing of cauliflower, if treated exactly like cabbage, except for the protection by the leaves, as above indicated. It can be grown in any garden, and forms so attractive and tempting a table vegetable that it should be among those grown by every person having a garden for the furnishing of his own table.

THE MORE IMPORTANT ROOT CROPS OF THE MARKET GARDEN.[1]

BY H. F. THOMPSON, SEEKONK, MASS., FORMERLY PROFESSOR OF MARKET GARDENING AT THE MASSACHUSETTS AGRICULTURAL COLLEGE.

The following-named crops form the root crops of most importance to the market gardener, namely, beets, carrots, turnips, parsnips, radishes and onions.

Beets, Carrots and Turnips.

These crops are usually grown from two main sowings, the first for the summer market, when the crop is sold bunched, and the second for the winter market, when the crop is sold busheled. The soil for these crops should be rich and mellow, a well-manured, deep, sandy loam being ideal. It is very important, especially for beets, that the soil be free from all free acid. To make sure that any acid condition of the soil is corrected, a liberal amount of lime, wood ashes or basic slag meal should be applied. A large bulk of fresh stable manure is not desirable where these root crops are to be grown. It is by far preferable, for these crops, to apply a heavy coating of good stable manure the fall preceding, and plow it in. By spring it will have become quite thoroughly incorporated with the soil, and be in excellent condition to further a rapid growth of these root crops during April and May.

Turnips are not nearly as extensively grown for a bunch crop as beets and carrots. The demand is much less and the difficulty of raising a satisfactory crop much greater, due to insect injury, particularly by the turnip root maggot. Beets lead in importance, with carrots second and turnips third. All of these crops should be planted early, about as soon as the land can be worked in the spring. Beets and carrots are usually planted in rows from 12 to 18 inches apart, and when the plants have reached a height of from 3 to 6 inches they should be thinned, to allow room for rapid growth and full development. Sufficient thinning is a distinct factor in early development. Beets should be thinned to 6 inches and carrots to 3. The thinnings from the early beets can usually be sold as beet greens,

[1] Crop Report for July, 1911.

at from 25 to 50 cents per bushel, and the amount received for them will ordinarily pay for the thinning and weeding. With carrots and turnips there is no such opportunity to get an early income before the roots are ready for market, although young turnips make splendid greens.

A fertile soil is essential to the best success with any of these crops, and without it quick growth and early maturity cannot be expected. In addition to a liberal application of stable manure, from 10 to 15 cords (20 to 30 tons), applied the fall previous to planting and plowed in, there should be applied 1,000 pounds of good quality lime and 1,000 pounds of high-grade commercial fertilizer, analyzing 3 per cent nitrogen, 8 per cent phosphoric acid and 10 per cent potash. This lime and fertilizer should be applied in the early spring. It is the best plan to apply the lime immediately after plowing, and deep harrow it, and put the fertilizer on after the disking, and work it in with the smoothing harrow.

The seed for these crops is sown with a seed drill, and put about one-fourth inch under the surface. It requires from 5 to 8 pounds of beet seed per acre, from 2 to 3 pounds of carrot seed and about 2 pounds of turnip seed. The rows of beets and carrots should be about 14 inches apart. The use of high quality seed is very essential to the largest returns, and it is wise to select the variety and strain of seed with considerable care.

The cultivation of these crops, if planted as above suggested, must consist almost entirely of scuffle or wheel hoeing and hand weeding. About three hoeings and one weeding, besides that done at the time of thinning, should properly take care of the crops.

The harvesting of beets usually begins by June 15, and a succession is desired throughout the season. In some markets bunched beets may be found in early winter, but as a rule the beets for winter use are sold by the bushel. To provide a succession of beets for bunching throughout the summer season more than one early planting is required. It is the custom to plant a very quick-growing variety for the first early, and Crosby's Egyptian is the standard variety for this planting. Following this planting by about two weeks, a little slower growing, rounder beet, is most popular. One of the leading varieties of this class is Detroit Dark Red. Some growers make still a third planting to supply bunched beets for their trade, and this occurs about May 15. The practice varies with the grower to a large degree.

For the Boston and Worcester markets beets are bunched four in a bunch and are sold by the dozen. The Providence market requires five in a bunch. This is varied somewhat according to the size of the beets. Most gardeners clean up the first early beets by July 15, and plant the land to a succession crop, — beans, celery, cabbage or the like.

It is a common practice to start beets in the hotbed or greenhouse, and to set the plants in the field. In this way the grower gets his crop into an earlier market, where it usually commands a higher price, and he is able to clear his land for a second crop at an early date. For plants to set in the field beet seed is sown under glass about the last of February, in rows about 2 inches apart. The plants are grown to a height of from 4 to 6 inches, when they are ready to set in the field. This usually occurs about April 15, and the harvest commences about June 1.

The price received per dozen bunches for beets varies greatly. It is often $1 per dozen for the first in the market and frequently drops to 25 cents per dozen later in the season; the average is about 40 cents.

Winter beets are planted from June 20 to the middle of July. It is possible in a favorable season on rich land, to get a crop fit for storing when planted as late as August 1, but this is unusual. The seeding and tillage of the winter crop are practically the same as already described. Detroit Dark Red is a good variety for this crop. The beets should be harvested before freezing weather occurs, but moderate frosts do them no injury, provided the ground is well covered with foliage. It is the general practice to top the beets in the field, care being taken not to cut the beets so close that they will bleed. A yield of from 200 to 400 bushels per acre is usual. These roots are stored in a vegetable cellar or temporary pit, as seems most desirable. It is necessary that they be accessible during the winter months. The essential conditions in the root pit are, (1) temperature close to freezing, but always above; (2) damp atmosphere; (3) some ventilation; (4) good drainage. In order that the roots may keep well they must be cool when put away and not piled too deep.

Beets have very few serious insect enemies. The spinach leaf maggot often injures the leaves for a time, and there seems to be no remedy for this pest. Cut worms are likely to be injurious when the plants are small. The use of poison bait made of bran, molasses and arsenate of lead, scattered on the ground where the seedlings are coming up, is as effective as anything in controlling this pest; late fall plowing will also help. Beets should not be planted on land where scabby potatoes have been grown, for they will be affected by the scab and their appearance considerably injured.

The tillage, fertilization and general care of carrots are similar to those of beets. Carrots are never transplanted, and they are usually thinned to a less distance in the row, as already stated. The same manuring and fertilizing recommended for beets will give satisfactory results with carrots. The harvesting season commences somewhat later, usually from July 1 to 10. The market uses bunched carrots throughout the summer season, although in late summer

bushelcd carrots find a ready sale. The planting for the winter crop should not be delayed later than July 1 on the best of land, and June 1 is a safer date to insure a heavy yield. Winter carrots are harvested from October 1 to 15, and pitted or stored in a cellar, as are beets. The sale for carrots is usually large during the winter months, and they are one of the best of the winter revenue getters. The leading varieties of carrots are, for the first early bunching, Guerande or Ox-heart, a short, thick, early carrot; for second early, Chantenay, averaging about 5 inches long and of good size and shape for bunching; and Danvers Half Long, the standard main crop carrot. The price of bunched carrots will average about the same as for beets.

The production of good turnips for early marketing is a harder task than the production of the two previously considered crops. The cause is the pest already named, the root maggot, which seems to be practically uncontrollable. Freshly manured land is especially likely to produce maggoty turnips. For this reason most turnip growers do not apply manure directly previous to the growth of this crop, but depend upon the supply of accumulated plant food in the soil and commercial fertilizer. A fertilizer carrying about 3 per cent nitrogen, 10 per cent phosphoric acid and 10 per cent potash serves well for this crop. The application should be at least 1,000 pounds per acre. Tillage for this crop is the same as for beets and carrots. It is common to allow turnips somewhat more room than beets and carrots, 18 to 24 inches between rows being more suitable. With 24 inches between rows horse cultivation is feasible. For the early crop the flat turnip is often planted, although the round or egg turnip is the more popular. The standard turnips for bunching for the New England market are the White Egg and the White Rock. There is a marked difference in the strains of turnip seed found on the market. It is well to experiment in a small way with seed of a number of strains when selecting a turnip, for the difference in quality is often so distinct that one strain is worth much more than another. The turnip crop for storage and winter sale is sown from July 15 to August 10, and the round white turnip is the most popular, although the yellow turnip or rutabaga is popular in some of our markets. It is well to have a supply of each. The rutabaga should be sown not later than June 15 to make a crop. The storage for turnips is the same as for beets and carrots.

Root Storage.

The storage of the root crops for winter is an easy matter, the requisites of a suitable storage being a uniformly low temperature, ranging from 32° to 40° F., but not below freezing; ventilation enough to prevent heating of the stored vegetables; and freedom from standing water, that is, good drainage. Root crops may be stored in any cellar where these conditions exist, in a regular vege-

table pit or a temporary outdoor pit. It is essential to the best results that the roots be put away after the weather has become cool, usually toward the end of October.

When put into a cellar they are piled about 2 feet deep, and usually keep best when covered with sand, so that the air does not come in contact with them. Some growers do not consider this necessary, and where the air is moist it is not essential.

Vegetable pits are usually constructed on a sidehill, or dug down 6 to 8 feet deep, where the roots are kept considerably below the surface of the ground. On such a pit a double-pitch roof is usually constructed, with an opening covered by a 3 by 6 foot shutter, or something similar. When the cold weather of winter is at hand the roof and sides above ground are covered with meadow hay, or strong horse manure, to prevent freezing. The most convenient location for a vegetable pit is a sidehill where the vegetables can be carried in on a level with the floor of the pit. Where the storage is large a cart can be backed into the pit, saving much expensive labor.

A temporary outdoor pit can be easily made in the following manner. Select a well-drained piece of land, in a convenient location. Stake out the pit about 6 feet wide and the length desired, having the long way of the pit extend north and south. With a single plow loosen the surface soil to the depth of 6 to 8 inches, and shovel this out either side, dividing the amount about equally. Then pack the vegetables on the ground, having the base of the pile about 5 to 6 feet wide, and bring it to a ridge in the middle, at a height of about 2½ feet. Extend this pile as far as desired, and make parallel pits if necessary. When the vegetables are packed in the pits cover with 2 inches of straw or meadow hay, throw 2 to 3 inches of earth on them and allow them to thoroughly cool. As the weather grows colder add to the amount of covering, until there is 4 to 6 inches of earth over the pit. To allow ventilation pull a little of the straw up at the ridge, so that the earth does not cover completely, and so that any warm air may escape. When the earth covering has frozen into a crust, cover with straw or manure, so that the frost will not enter the pit. Instead of covering with earth at the south end use a liberal amount of straw as protection. When vegetables are wanted pull away the straw and take out what are wanted, breaking down the pit as the vegetables are removed. This outdoor pit, while temporary, gives very satisfactory results.

Parsnips.

Parsnips are a long-season root crop, which ought to be planted before the first of May, and will occupy the ground until late into the fall, sometimes until the following spring. There is a very limited sale for them bunched, but some market gardeners find such a sale profitable. Parsnips require a deep loam. A rich, sandy loam is

ideal for their best development, and, as with the other root crops, the manuring of this crop should be done the season preceding its growth. The same fertilizer that has been recommended for the other root crops is suitable for this crop, and the same amount. Parsnip seed is sown with a seed drill, in rows 12 to 18 inches apart, and is usually sown quite thickly, for it is weak and requires some time to germinate. It is a common and proper practice to sow some seed with the parsnips which will germinate quickly, and mark the rows so that it will be possible to go through the piece with a wheel hoe before the parsnip seed is up. Lettuce and radish seed are both suitable for this purpose. Hand weeding and thinning are required, and the plants should be left about 3 inches apart in the row.

Parsnips started early will sometimes be ready to sell bunched in July. About four or five are put in a bunch, and the price averages about 50 cents per dozen bunches. The usual time of harvesting is in September, October and November. During these months there is an increasing market demand, and those not sold directly from the field are taken up in November and put into a pit. The yield of parsnips per acre varies from 300 to 600 bushels. The ideal size is about 2½ inches across the crown and about 12 inches long. They should be smooth and white. It is necessary to wash them for some markets, while others take them unwashed. It is often possible to sell both washed and unwashed, the former bringing from 10 to 15 cents more per bushel than the latter. When parsnips are put into the pit it is necessary to pack them so that the roots remain straight; otherwise, when taken from the pit, many roots will be crooked, and will have to go as seconds.

The varieties of parsnips are few. The standards are Hollow Crown and Long Smooth; the former is the more popular, being somewhat larger for its length and not growing so long.

There are practically no diseases or insect pests that trouble the parsnip. Some crops will appear rusty, due to soil conditions, and rotation will usually remedy this trouble.

The greatest labor in the production of the parsnip is the digging. It is usually best to use a plow, and plow close to the row; then the parsnips can be pulled by hand, and the next row plowed out in the same way. Parsnips may be wintered over in the ground where grown, but this practice is hardly suitable for the market gardener. It is better to have the crop where it can be readily put on the market during the winter. If left until spring the digging is likely to interfere with spring work and the land not be available for very early planting.

Radishes.

Radishes are in a class by themselves as the quickest and most easily grown of garden crops. They do well in a rich, light, sandy loam, but need to have a good supply of moisture to make a select

round radish. This crop is usually planted as a companion crop, a filler among the slower growing, coarser crops, and requires little cultivation beyond that necessary to properly prepare the ground. Radishes can be readily grown to marketable size in three weeks from the time of planting, and make a sufficiently rapid growth to keep ahead of the weeds.

There are two principal types of the short-season radish offered by the seed trade. They are the round radish and the olive shaped. The round type is the more popular and Scarlet Globe is the standard market variety. As is the case with most vegetable crops there is a wide variation in the quality and uniformity of the crop raised from different strains of the same variety. It is very important to obtain high quality seed and no person can safely economize by buying cheap seed.

The demand for radishes is most brisk in the early spring, but a moderate sale can be found for them throughout the summer season. The market price varies from 5 cents per dozen bunches to 20 cents per dozen, with an average between 10 and 15 cents. Radishes can be raised at a good profit at 12 cents a dozen where labor can be obtained that will bunch them cheaply. The cost of bunching should not exceed 2 cents per dozen.

In order to have a constant supply of radishes successive sowings must be made throughout the season, at intervals of about a week. The best rule is to sow seed when the lot preceding has gotten above ground. The sowings are then somewhat regulated by weather conditions, which vary the rate of growth. For the Boston market radishes are bunched from 7 to 12 per bunch, and packed roots up in bushel boxes, averaging about sixty bunches per box. It is not good policy to follow one crop of radishes with another, but better practice to raise each crop on different ground.

The only serious pest of radishes is the root maggot, which does much damage in early spring. It is often the case that one or two sowings are complete failures because of this pest. There is comparatively little trouble from this insect later in the season. There is no remedy known.

There is some sale for a large white radish, among some of the foreign trade, during the summer. The varieties usually grown are the Large White Globe and White Strasburg. There is little market for these radishes outside the big cities.

Onions.

While onions are not a root crop, properly speaking, they are treated somewhat similarly, and may well be considered in such an article as the present. As grown by market gardeners they are logically classed with the crops just considered, and are handled in a very similar manner. The market gardener finds a sale for onions

when the size of a pencil, as bunched onions or rareripes. He also grows them for bushel onions, more often producing the ripe onions from sets than from seed. Sets are small onions, about the size of a marble, which are put into the ground the last of March or the first of April, and which give one of the first crops from the garden.

Growing onions from seed is most often practiced when they can be handled as a companion crop. One of the most profitable combinations is that of celery and onions. Celery seed is sown in rows 4 to 5 feet apart and three or four rows of onions are sown between. In order to make this cropping successful the land must be filled with plant food and plenty of moisture. The seed for both these crops is sown early in April, before the 15th if the ground can be made ready. The rows are spaced about 12 inches apart. Where late celery is so grown the rows must be farther apart. The onions from this seeding are ready to harvest in late August or early September, and the room given to celery when it is making its most rapid growth. It is often the custom to use onion sets instead of seed between the celery rows. The onions grown from sets are harvested in July.

The best soil for onions is a medium, heavy loam, well filled with humus. It is best to use a large amount of manure for the crop preceding the onions and not apply much fresh manure for this crop. A commercial fertilizer analyzing 4 per cent nitrogen, 8 per cent phosphoric acid and 10 per cent potash is suitable. The application should be 1,000 pounds to the acre. Growing transplanted onions has become a common practice among market gardeners. The advantages are earlier maturity and the possibility of producing long-season varieties of greater size and better quality than can be grown from seed in New England. Prizetaker is the variety most commonly so grown. The seed of this variety is sown about February 15, under glass, either in the greenhouse or hotbed. A single hotbed sash 3 by 6 feet should cover from 5,000 to 8,000 plants. About twenty sashes are required to grow plants enough for an acre. The labor in setting these plants is great, but market gardeners find this method of growing onions profitable. The plants are set in rows 12 to 15 inches apart, and from 3 to 4 inches apart in the row. Boys will often do the transplanting as well as men and at a less cost to the grower. A nimble-fingered boy should set 3,000 plants a day. The land must be in good tilth, moist and not too firm. The onion plants should be about pencil thickness to give the best results, although smaller plants are often used. For setting, the rows must be marked, and where boys do the setting it is well to mark the spacing in the row.

Growing onions from sets is a most common practice. Most of the onions grown for bunching are so started. Many growers plant large areas to sets and sell as bunched onions all that it will pay to

handle in that way; the rest are left to mature. Onions are repeatedly grown on the same land with decided success, and seem to prove the exception to the rule of rotation. The standard varieties of onions grown by the market gardeners are Yellow Globe Danvers and Southport White Globe; for transplanting, Prizetaker. The Danvers is by far the most popular. The average yield of onions is about 500 bushels per acre, although it is not unusual to obtain as many as 800 to 1,000 bushels.

Onions are easily stored, the requisites being, (1) proper curing in the field; (2) even, dry temperature, between 35° and 40° F.; (3) good ventilation. One freezing will not seriously injure the crop after it is put into storage, but repeated freezings and thawings soon spoil it. If the crop is frozen, and is not allowed to thaw until sold, little damage will occur. The market gardener usually handles his crop in bushel boxes and does not attempt to hold many for the winter trade. The average market price for dry onions is about 60 cents per bushel, while the early crop often sells for $1.

The insect pests of onions are mainly two, the maggot and the thrips. The onion maggot hatches from an egg laid by a small fly near the base of the plant. The egg hatches in a few days and the maggot eats into the bulb, causing decay and spoiling the plant. There is little that can be done, and the injury is not usually so extensive as to destroy a large percentage of the crop. The onion thrips is a small insect, not noticeable except to the close observer, which eats the stalk of the onion. In a dry season it is likely to be quite injurious. About the only satisfactory remedy is overhead irrigation.

Onions are attacked by one disease which is quite injurious when once introduced. It is called onion smut, and lives in the soil from season to season. The best remedy is rotation. It has been found that an attachment to a seed sower whereby the seed and adjacent soil can be moistened by formalin will largely control the disease. Dr. George E. Stone of the Massachusetts Agricultural Experiment Station has developed this treatment.

BEANS, CORN, TOMATOES, LETTUCE AND SPINACH AS MARKET-GARDEN CROPS.[1]

BY HENRY M. HOWARD, DIX FARM, WEST NEWTON, MASS.

Under this title the crops of beans, corn, tomatoes, lettuce and spinach will be considered, with brief remarks on how to have them in good condition for market during the whole season of possible outdoor growing.

Beans.

As a market-garden crop beans are raised to sell green, either as string beans or shell beans. For the earliest planting select well-drained, light soil, and manure liberally in the row, using about 10 cords of well-rotted manure to the acre. Cover the manure in with a smoothing drag or harrow, and sow the beans by hand or machine, so that they will stand six beans to a running foot of row. Cover the beans not over 1 inch deep. Have the rows 2½ feet apart. Sow the beans every few days from April 8 to May 1, and sow again May 15, and once a week thereafter until August 1. Do not figure on getting a profitable crop from anything sown after August 4. For all sowings of beans after May 1 the broadcasting of manure will be advisable and heavier ground may be used.

Beans will increase in yield immensely, almost double, when irrigated properly. The vines when young will ordinarily get all the moisture necessary, up to podding time, from the rainfall. It is at podding time that water can be used to best advantage.

The earliest crops of beans will make from 100 to 150 bushels per acre, and sell for something like $200. The later crops of beans will produce more bushels, and often bring in fully as much money.

If proper succession plantings are made you may have beans to sell from July 1 to October 1.

Good varieties to plant are Red or Black Valentine for the round-pod and Bountiful or Long Yellow Six Weeks for the flat-pod green sorts. The Wardwells Kidney Wax is the most popular wax variety. Of the varieties used for green shell beans the Red Pod Horticultural of some strain will be found most satisfactory. Try to find some strain which has done well in your vicinity and plant that. The

[1] Crop Report for August, 1911.

early and late crops of this bean seem to be most profitable and least liable to spot. It may be planted as early as April 8 and as late as July 10, with a fair show of getting a crop. New land or land lately in grass seems peculiarly adapted to Red Pod shell beans. Pole varieties of the Red Pod beans are often very profitable. Brockton and Worcester are standard varieties.

To get beans up well in a dry time pursue this method carefully: open three furrows with the plow, sow two of these and cover them 2 or 3 inches deep, leaving one row as a guide. Open two more furrows and sow two, and so continue till the plot is planted. Do not leave the open furrow exposed to the sun over fifteen minutes if you would like to have good results. A Planet Jr. No. 5 seed drill is a good machine to sow and cover beans with, but even then the plow should be used in a dry time and the machine run in the bottom of the furrow. A careful plowman can cover beans very nicely with the plow, and for summer planting there is no better way than to have the plowman open the furrows and cover the seed while another man sows the beans. Beans are considered good for seed up to three years old.

Corn.

Since the New England Corn Exposition of November, 1910, with its lectures and literature, there seems to be little left to say in regard to corn culture. Market gardeners plant corn early in April, from the 8th to the 15th for the Corey variety, in rows 4 feet apart and hills 2 feet apart, putting in eight or ten kernels to a hill, and covering not over 1 inch deep. Some plant by hand, but much of the planting is done with the Planet Jr. No. 5. Spinach is sown between the rows of corn.

As soon as the spinach is harvested a thorough cultivation with the plow and cultivator is given, and the corn thinned to three or four plants in a hill and hoed. The corn is hilled or ridged up at the second hoeing, and all of the cultivation given with the horse cultivator, running it through the rows as often as once a week until the corn is in silk.

About the 1st of July, when the corn is in silk, the ground is thoroughly wet down and celery set between the rows. This watering makes a sure thing of the corn crop, hastens maturity and improves the quality of the corn. Corn treated in this way will produce a crop worth from $150 to $200 per acre, and should mature from July 20 to 25.

The Crosby corn can be grown in the same way and with the same combination, at a good profit. It matures from July 25 to August 1.

By succession planting sweet corn may be had every day from July 20 to October 20. Plant April 8 to 20, then May 10, and every two weeks until July 1. It is not safe to figure on a good crop from any seed sown as late as July 10, but often we get corn from

seed sown as late as July 17. If the corn fodder is of good size the ears will fill out considerably after being cut by a hard frost. The large number of ears which will mature after a hard frost will greatly surprise one.

Sweet corn is sometimes started in pots in a greenhouse or hotbed, and then hardened off and set in the field. By this system sweet corn may be had ready to market by July 7.

Some market gardeners raise a little of the yellow varieties of sweet corn, but the market demand for them up to this time is very limited. Golden Bantam and Ordways Yellow seem to be the most popular, the latter having the larger ear.

Tomatoes.

This is a crop most easily grown, a great money producer and usually very satisfactory. We need to have good plants, of good variety and set early in order to get the best returns. No one who cultivates an acre of tomatoes should be satisfied until he is able to raise and sell a crop which will make a gross return of $900 per acre. The average returns are not over $400 per acre.

There are many varieties of tomatoes to select from. Often some local variety or strain will be found most profitable. The writer has found Sparks Earliana, Chalks Jewel and Stone three very satisfactory varieties. The Earliana comes large and early, and will make a very heavy crop before the price goes off. Chalks Jewel is also a heavy cropper, very smooth, a good second early variety and a good money maker. The Stone is no better than Chalks Jewel, but is a little later and possibly a little larger plant. The Earliana is well adapted to growing on rich land and is a good market-garden variety.

To get good plants start them by February 22 in a hotbed, and transplant as soon as the second leaves appear. Keep growing with plenty of air, to make sure of a stocky plant. About the middle of April transplant to a hotbed with mild heat, say 4 to 6 inches of manure, and set the plants 50 plants to a sash. In a few days go over the beds and nip out the growing top of every plant, so as to make the side shoots appear. This nipping will cause several branches to start, and when the plant is ready to set in the field there will be from three to five branches, and all in bloom, or with fruit on, and the plants will stand fully 15 inches high.

In preparing the field for tomatoes plow deeply and harrow and level. Furrow out deeply one way and cross mark the other. Set the plants down deep and hoe in the manure around each plant as set. Manuring in the hill is very satisfactory with tomatoes. Plants of Earliana should be set 3 by 4 feet, Chalks Jewel 3½ by 5 feet and Stone 4 by 6 feet.

If the season is one when the vines make a rank growth they

should be carefully spread out over the hill or ridge. If they continue to grow rank cut back the tops with a grass hook. Tomatoes like cultivation, heat and water. Stir the ground often, ridge the soil up to the plants and water if you can. Water will increase the size and improve the quality of the crop. Tomatoes like a piece of new or sod land, and always seem to mature earlier on that and are usually smoother. Training tomatoes on a trellis or tying them to stakes is a method of raising largely practiced on some farms, and is considered very profitable. The fruit is much smoother and brighter and brings a higher price under this system.

Lettuce.

This is a crop most easily grown and is very profitable when the market price is high. It is easily spoiled with too much manure and water, too great heat or hail storms. Lettuce will not head if too little manure and water are present, however good the temperature may be. When the weather conditions are unfavorable only the best gardeners have lettuce to sell. The land for lettuce should receive about 30 cords per acre of fresh manure every year in early spring. This manure must be well plowed in. I would not hesitate to plow in manure at any time in the year if I thought the land needed it to carry a crop.

Lettuce is very hardy, and may be sown as early in March or April as the soil can be made ready. Early sown seed needs to be barely covered, but later sowings may be covered about ½ inch deep. Germination will be found most complete when covered only ¼ inch, but it is not so easy to maintain the moisture condition favorable to the crop with so small a covering late in June or July. The first sowing should give the first heads fit to sell by June 10.

Lettuce may be had in the open by May 20 if care is taken to raise the plants in a hotbed and set out in the field about April 10, when well hardened. The seed for such plants should be sown about February 20 in a hotbed, and the young plants set over about March 1, putting 200 plants under each sash. Use plenty of water when transplanting lettuce in the open. In the early spring season choose a warm, bright day, when there is no wind, as the most favorable weather conditions will make a great difference in the growth of the lettuce plants. A few warm days right after setting will give the plants a good start, and then they will stand a little hard weather. Many people think there is an advantage in transplanting lettuce to make it head. There is no such advantage. Proper amounts of manure and water and favorable weather conditions are the most important factors.

When a crop of lettuce is well spread out, covering the ground, and the ground is dry, it should be thoroughly wet down, using as much as 2 or 3 inches of water. Put this water on at night by use

of some irrigation system like the Skinner system. Do not water lightly or at midday, as the lettuce is liable to burn in either case.

Lettuce will head very rapidly under favorable conditions and a crop come off in a week to ten days. For succession crops I have followed this system. Plant as early in the spring as possible. Make the next sowing May 1, and then sow every ten days until June 20. From June 20 to August 4 I like to sow once a week. Never expect to make a profit or get a crop from lettuce seed sown later than August 4. Varieties for open-air culture are listed under many names. A good strain of Black Seed Tennis Ball is the best all round lettuce I have ever raised. Other varieties have been tried, but I have found this to be the best.

Lettuce to grow well under glass should be of a variety especially adapted to glass.

The profits from lettuce vary immensely from year to year, and from one season to another in the same year.

Spinach.

This crop is used to fill space between rows of corn, beans and tomatoes, and is often planted in a field by itself. The ground must be very rich to produce early spring spinach. The manure should be well rotted, and manure from piggeries seems particularly adapted to growing spinach. Cow manure is also first class for fall spinach. A small amount of manure may be assisted by using 200 to 300 pounds of nitrate of soda or sulfate of ammonia per acre. The nitrogen fertilizers will give the spinach a deep green color. They are most satisfactory when used in conjunction with manure.

Spinach should be sown thickly in the row, and the rows should be about 6 or 7 inches apart for the earliest spring sowing, using 25 to 40 pounds of seed per acre. Later sowings should be with less seed in the row.

Spinach is wanted in the market up to the middle of July, and then the demand drops off. About September the demand begins again and increases up to November. Succession plantings can be made from the earliest opportunity in the spring until June 15, and from July 20 and every week thereafter until September 12 for fall and winter use.

There is a leaf miner which is liable to spoil spinach, but when in the egg stage it is easily seen, and the crop may be sold while yet unharmed. If the leaf miner spoils the crop plow it under and try again. Do not be satisfied in growing spinach until you have secured a crop of 2,000 or more bushels per acre.

To get the best fall spinach the seed should be sown rather thinly, and if the plants stand too thickly they should be thinned to stand 2 inches apart. Great large-leafed spinach can thus be obtained, which will bring double the money received for ordinary spinach.

A small application of nitrate of soda to late fall spinach will keep it from turning yellow.

To winter over spinach in the field sow on well-drained land, rather thickly, from September 1 to 12. When cold weather comes, and in any event by December 1, cover with sedge, straw or fine boughs, for the winter. In early spring, March or April, remove the covering, and treat with sulfate of ammonia, hoed in. Spinach will live over on some land with no protective covering. It will be found a profitable crop for most market gardens.

SOME OF THE ESSENTIALS OF BEEKEEPING.[1]

BY BURTON N. GATES, PH.D., INSPECTOR OF APIARIES, STATE BOARD OF AGRICULTURE, AMHERST, MASS.

INTRODUCTION.

This bulletin is not intended to be comprehensive of all beekeeping, but rather a guide to some essentials, adapted to the beginner, the avocational or the family beekeeper. Since Massachusetts already has an extremely large number of apiarists who keep only a few colonies, the special demands of the industry suggest the need of greater expertness, efficiency and larger beekeeping. There is also opportunity for a better distribution of apiaries. For instance, some localities are entirely destitute of bees, while others possess a considerable number. To be sure, some localities — Worcester County and the Berkshires — are more profitable than others, but greater earnestness and general efficiency will result in a greater and general productivity.

THE OUTLOOK.

The opportunity for beekeeping and the prospect for profit are encouraging. With the suppression and control of infectious bee diseases, which in recent years have caused inestimable loss and discouragement, a new life for the industry is inevitable. Moreover, the Commonwealth is small and markets are especially accessible. There is a dense and growing population, and the fact that it is composed partially of Europeans improves the demand for honey. The utilization of bees in horticulture, orcharding, market gardening and cranberry culture is fast becoming more thoroughly understood and practiced. Encouragement, organization of the beekeepers for the exchange of ideas, demonstrations and protection, — all these promise to further a wholesome and fundamentally important industry.

To the majority, beekeeping is mysteriously fascinating, so that "once a beekeeper, always a beekeeper," is almost proverbial. It affords recreation, a pastime for those in confining professions. But it cannot be too strongly emphasized that bees *require attention,* and this at precisely the proper time. They respond in proportion to

[1] Crop Report for September, 1911.

judicious manipulation. Thus, neglect means failure and disappointment. In contemplating beekeeping, unless willing to properly and promptly care for the colonies, the prospective beekeeper had better not undertake the venture. Perhaps the best qualities which a beekeeper acquires are punctuality and precision.

Massachusetts is suited to Beekeeping.

Any county in the Commonwealth will support bees, even sandy Cape Cod reporting profitable returns. Beekeeping in the heart of a city can hardly be expected to yield as handsomely as in the country, but even in the city it is possible for a colony to maintain itself. Apiaries of some considerable size are found on roofs of business blocks in most of the large cities in the country. Preferably, however, for the greatest results, the apiarist should know his flora, the plants which yield nectar, their abundance and their periods of bloom. Then an apiary can be intelligently located. A garden plot or an acre of clover or buckwheat does not necessarily mean big returns in honey. Bees forage on a radius of at least two miles.

Locating the Apiary.

In commercial honey production, the selection of the apiary site receives deliberate consideration. Shelter from prevailing winds, a relatively level spot, upland and not swamp, remoteness from stock or pedestrians, aside from the general consideration of the honey-producing flora or bee forage, are important. The matter of shade versus no shade in the apiary has attracted considerable attention, but without proving the advantage of one over the other. As a whole, bees thrive best in the open, but the hives should then be protected by shade boards or ventilated covers, in order to overcome the melting down of the combs or sulking or "hanging out" of the colony in excessive heat. It is usually thought that in the open bees fly earlier and perhaps gather more nectar than when colonies are under trees. Too dense shade, which results in dampness, is to be avoided.

Usually an effort is made to turn the entrances of hives from driving winds, and apiaries frequently face the rising sun or the south, and seldom the north or northwest. Stone walls, sheds, hedges, forests and orchards make good windbreaks. The old custom of building sheds open on one side, under which to keep the colonies, has been largely abandoned. Such sheds hinder the easy and proper manipulation of the hives. Arranged in groups or rows, slightly elevated from the turf, in order to overcome dampness and the intrusion of pests, the colonies may more easily be attended to than if shelved. Grass and weeds should not be allowed to obstruct the entrances.

Materials for Maintenance.

Manufacturers present a large variety of hives and other equipment from which the beekeeper may choose his type of hive and the accessories. Not everything advertised is necessary for a small apiary. It is advised that hives and fixtures be purchased, rather than made at home, at least for a start and a pattern, in order to secure accuracy of measurements and interchangeableness of parts. Nothing is more annoying than to have misfits. For a similar reason the advisability of selecting and continuing one type of hive, say the ten-frame Langstroth, cannot be too strongly emphasized. The prospective keeper of bees should secure a collection of supply catalogues, study them, gain acquaintance with their technicalities, and then, selecting the type of hive most to his liking, purchase an equipment. Few parts and simple construction are features to be sought. The disadvantage of the old-fashioned box hive being so apparent to any one contemplating beekeeping to-day, it is scarcely necessary to say that only equipment with removable frames and combs should be considered.

Aside from the body of the hive, in which the frames are hung and the brood raised, hence called the brood chamber, there is a bottom board, with entrance for the bees, super or upper body in which surplus honey is stored and removed, and a cover. The bottom board is recommended to be of 7/8 inch stock, in order to secure rigidity, reversible, and should have a full width entrance. Those which are reversible, giving both a shallow and a deep entrance, are convenient. Most of the super types on the market to-day will serve. The purchaser must determine, however, what the nature of his honey product is to be, then select his super, remembering to look for simplicity of construction. For a cover, the writer has been particularly pleased with metal roofed covers, consisting of a thin, inner board and a telescoping, metal-roofed outer cover. This is ventilated, water proof, ridged and durable. There is no danger of overheating the bees when it is used. There is also little danger of this cover blowing off.

In order to prevent the queen from going above to lay in the supers, or compartments where the surplus honey is stored, a thin board, with perforations which permit the passage of worker bees but prevent that of the queen, is desirable. This is termed a queen-excluding board. The modern wire construction is admirable. A similar board in which is fitted a metal device, the Porter bee escape, when placed beneath the super, will allow the bees to pass from this surplus compartment but not to return. Thus the honey can be removed with little labor. It is spoken of as a bee-escape board.

Selecting the Type of Hive.

The majority of beekeepers, especially large commercial producers, use the Langstroth hive, invented in 1851. This may contain eight or more frames, the present preference being for the ten-frame capacity. Furthermore, it is desirable to secure the new, 16¼-inch dimension hive body, permitting the use of ten frames and a division board, which follows after and confines the frames.

The Use of Foundation.

Experience shows that too few beekeepers, in this State at least, appreciate the advantage of using foundation, which is merely a basis for the construction of true and perfect combs. Foundation is composed of pure beeswax; *it is not artificial comb.* It is merely a sheet of wax in which the shape and dimensions of worker cells are impressed. Foundation, when given to the bees, is drawn out by them and elaborated into combs uniformly of worker cells. In naturally built comb there is a well-defined tendency in bees to construct a high percentage of drone cells. An excess of drones in the hives is to be guarded against. A further and important advantage is, that each comb constructed on full foundation in frames, may be removed without damage to itself or the adjoining ones. Remember, too, that according to various estimates, from 10 to 20 pounds of honey are consumed by bees in producing 1 pound of comb.

Of course, it is essential to use but a half-inch strip of foundation in the tops of the frames when treating for disease, but the combs constructed may be removed later and full sheets of foundation substituted.

Beekeepers are urged to use full foundation whenever possible; it will prove economy in the long run.

Other Equipment.

In so old a State as Massachusetts it hardly seems possible that any one should attempt to maintain bees without a smoker. It is an indispensable instrument, without which, at times, most bees cannot be handled. Buy a strong, modern smoker, of good capacity and standard pattern. They cost less than a dollar and will serve for years.

The beginner in beekeeping should not brave the attacks of his bees by failing to use a veil. Cloth veils, made of cotton tulle, or the wire-constructed Muth pattern, if properly worn, are bee proof and comfortable. The supply merchants also furnish inexpensive gloves, which not only protect the hands but give a beginner added confidence.

In order to pry apart fixtures and scrape away refuse propolis,

a hive tool should be constantly at hand. This can be purchased at a small cost. An inflexible putty knife is excellent.

Other almost indispensable apparatus can be listed and studied from catalogues. For fastening foundation to the wires in the frames, see wire embedders. For securing foundation in the surplus honey boxes or sections, study foundation fasteners, some of the recent, inexpensive types proving admirable. A few queen cages, for introducing, are serviceable, but may be constructed at home. A German bee brush, some perforated zinc, feeders, Alley drone traps, honey boards and Porter bee escapes will be useful.

Getting the Bees.

Getting the bees is easy, but there are several necessary precautions. Commence on a small scale for the first year and increase in proportion to experience. Increase, swarms will come fast enough; sometimes it is a serious problem to know how to prevent building up too large an apiary. Usually beginners find it desirable to have not more than three to five colonies. With a beginning in May, which is a suitable time of the year, frequently the apiary will have doubled by fall, giving in addition a surplus of honey.

The primary precaution, at present, in buying bees is that they be healthy or free from brood disease, a subject referred to under "Hygiene of the Apiary." The question immediately arises, "How am I to tell that the bees are not diseased?" It may be possible upon inquiry to purchase colonies which have been inspected and pronounced healthy. Sometimes an experienced beekeeper can be procured to pass judgment. Furthermore, in case of doubt, if a sample of the brood be sent to the Bureau of Entomology, Washington, D. C., or to the writer, an examination will gladly be made.

A relatively safe way to secure bees is to take a clean and equipped hive to a beekeeper, instructing him to introduce a large, early swarm. This is an inexpensive means of securing a good, vigorous colony.

Colonies may sometimes be caught in the woods by setting out empty hives. Various baits are used. A hive previously occupied by bees is attractive to swarms, but this method of securing colonies as now practiced is objectionable, and should be discontinued. Inasmuch as empty combs and sometimes honey are used as bait, there arises great danger of spreading infection through robbing. Beekeepers are, therefore, warned against a possibly unlawful act.

In purchasing a hive of bees it will be most advantageous to secure them in the movable-frame type of hive, which the prospective buyer should previously have selected as his standard. A beginner is advised not to purchase colonies in boxes, kegs or old-fashioned box hives, which requires practice in order to transfer the colony to a frame hive. This, while it affords excellent experience, is a handicap and is usually expensive.

Summing up the suggestions for a beginning: —

Purchase disease-free and strong colonies, preferably good Italians, and in the modern type of frame hive which has been decided upon. A favorable time of the year to commence is in the spring. If it can be arranged, allow an experienced beekeeper to attend to transportation, a problem which sometimes perplexes the veteran.

Italianize.

The various races, types, strains or varieties of bees, such as Carniolan, Banat, Caucasian, Cyprian, the African races, and some of the Italian strains have been much and often over-exploited. An eminent German authority has aptly said that the Americans are so anxious to try new races, they import so many strains, that they have no truly efficient, strictly American honey bee, which may be said to be characteristic of or adapted to any one locality of the United States.

In Massachusetts this is perhaps especially true, because of the many who keep bees from general, natural history or avocational interest. The serious beekeeper, however, in the Commonwealth, as elsewhere, prefers the Italian or "hybrid" (German (black) and Italian cross). Even among the Italian stock, which is widely admitted the best race, all purposes considered, there are varieties which are less desirable than others. "Hybrids" should be abandoned for pure Italians.

As a whole, Italians which are less susceptible to European foul brood are good honey producers, prolific, gentle, easily handled, not excessive swarmers, hardy and the bee for the professional. Massachusetts beekeepers are urged to Italianize, if for no other reason than the tendency of Italian strains to resist European foul brood. Generally, the so-called "leather-colored" Italian is preferred to what has been termed "golden" or the "light-yellow colored" types. If you find a good strain keep it and rear new stock from it.

With the slight labor of a few minutes spent in introducing a queen, colonies which are vicious, hybrid or unproductive, may be completely restocked and transformed in the course of a few weeks, since the life of a working bee is approximately forty days. Thus an undesirable race may be changed for prolific, gentle Italians.

Requeening.

The success of a honey crop depends upon young and vigorous bees, and their presence is now considered a most important factor in the elimination of swarming. The commercial apiarist would requeen at least once in two years; many requeen annually. By requeening in August, the wintering ability of the colony is increased, the tendency to swarm the following spring is reduced, and productiveness and efficiency in the summer are secured.

Purchasing Queens.

Queens may be purchased from early spring (in the south) to late fall. Usually Massachusetts beekeepers can secure stock raised in the State, there being at least four commercial queen rearers. Queens so secured are mated, and, consequently, introduce new blood into the apiary. They are transported by mail in a small wooden cage which also serves as an introducing cage. Directions accompany each queen. Their trade classification is as follows: "Untested;" a mated queen but unproved, her progeny not having been matured. "Tested;" the purity of the mating of this queen has been proved by her progeny. "Select tested;" these queens are usually older, and have proved themselves prolific, truly mated, etc. "Breeding queen;" such queens are carefully selected for superiority and characters worthy of being propagated. The cost of queens increases proportionally to this classification.

Increase.

Naturally, increase and dissemination of the species are accomplished by means of swarming, yet it is no longer considered an index of prosperity. In this thrilling event, the wildest and most exciting situation in all beekeeping, the parent stock, 20,000 strong, issues from the hive to form a new colony, leaving the brood and emerging bees, with queen cells and honey, behind, to continue the old one. The act of flying forth, the issuing of the bees with their parent queen, is called swarming. Eventually they find a new location and establish their new home. Thus one stock produces two, these two may give two more, and so the apiary grows.

Artificial or Controlled Increase.

The old way of securing more colonies was based precisely upon this natural behavior, — swarming. The beekeeper trusted to luck that his bees would swarm and not fly away. But experience has shown it uncertain. Usually the parent colony yielded little or no honey the year that it swarmed. Later, beekeepers commenced to divide their colonies, brood and bees, into two or more parts or nuclei, supplying each division with a queen or allowing the bees to rear and mate one. Gradually these small colonies or nuclei strengthen until fall, when they should become full size. But this means usually affords merely increase. Moreover, these nuclei require considerable attention, nursing and feeding, which means little economy.

The modern methods of increase are based on an effort to keep strong both the old and the new colony, without the sacrifice of the honey harvest.

Shaking for Increase.

This has virtue not only in increase but also in overcoming the swarming nuisance. The principle has many modifications and is commonly explained under heading of "shook" swarming. Here, again, the natural impulse of the bees to swarm is taken advantage of. A hive is prepared as for hiving a swarm, that is, an empty hive is equipped with frames containing either full sheets of foundation or foundation starters. This is set on the stand in place of the colony to be shaken. The readiness of the colony is determined by its preparations to swarm. A frame of sealed brood, from the old colony or elsewhere, is set in the center of the new hive. The queen is then placed on this frame. A majority of the bees are next shaken from their old combs which, when completed, will have stocked the new one on the old stand. The old hive, combs and the remaining bees (enough should be left to care for the brood) is set on a new stand. The newly formed colony will recover and build up rapidly, being almost immediately ready for supers, which should be placed over a queen-excluding zinc. This is done to prevent the queen from laying in the section boxes. The colony from which the bees have been shaken may be allowed to rear their new queen, or, more preferably, a cell, virgin queen or mated queen may be provided them, at the beekeeper's discretion. A laying queen, of course, builds up the colony more rapidly.

The experienced beekeeper can readily see how this procedure can be used to advantage in treating for brood diseases of bees. Of course, it is necessary to modify the method, using only half-inch starters of foundation (strips one-half inch in width), and omitting to put the sheet of brood into the new hive. Without brood in the new hive, a queen guard, perforated zinc, or Alley trap should be put over the entrance, in order to prevent the colony from absconding. The exchange of supers should also be avoided.

Another method, which is quite as satisfactory, is to establish a new colony by the removal of frames of hatching brood with adhering bees from several colonies. These, in a hive to which a queen is introduced, rapidly establish a thrifty colony without materially reducing the parent stocks. The force of bees can also be increased by substituting this newly formed colony on the stand of another strong colony and thus catching the returning field bees. The loss to the populous colony which was removed is slight. After moving the new colony in this way several times, remarkable increase in strength can be obtained. Such procedure, or the transferring of combs from hive to hive, in any case should be rigidly avoided in any apiary where the presence of brood disease is suspected.

The reader is also referred to the method, recommended by the

late E. W. Alexander, which is gaining much favor. This is virtually a modification of the "shook" swarming method, but without the shaking.[1]

Spring Management.

The honey harvest depends upon correct management of your colonies in the spring. Spring conditions depend upon success in wintering, and it is said wintering depends upon preparation the previous season. But with the first flight of the bees, when trees are beginning to swell their buds, the beekeeper's season commences.

Each colony should be thoroughly overhauled, provided, of course, that spring has really come. Opening colonies when bees are not flying should be avoided. A great deal of labor for the bees can be saved by scraping from the bottom boards the winter's accumulation of débris. At this season the beekeeper should scrape the top bars of the frames, remove surplus bee glue (propolis), that the parts may handle more freely during the rest of the summer. Also look for your queens, which sometimes fail to survive the hardships of winter. The presence of brood or eggs should be a guide. If there seems to be a failure of the queen, or if she is lost, a new one should be provided immediately, or else the rapidity with which the colony may dwindle will be surprising.

The honey stores, as the colony expands brood rearing, vanish almost mysteriously. Consequently it is imperative that provisions be constantly available. Remember, too, that very little nectar can be gathered in the field, since perhaps maple and skunk cabbage are the only flowers yet open. It is frequently desirable and necessary to feed. (See "Feeding.")

To know what to do with small or weak colonies is often a problem. They had better be united, a queenless one with a queen-wright, some advise. To nurse along a weak colony means care, which is not always repaid by a surplus of honey.

E. W. Alexander has given a method of building up weak colonies in the spring. Those who have tried it do not all report it a success, but the writer's experience is favorable. Beekeepers should undertake it with caution, but nevertheless surprising results have been obtained.

According to Alexander, the apiary should be divided into an equal number of strong and weak colonies. Again, mark each of the weak colonies which has brood. Placing queen-excluding zinc over the strong colonies without disturbance, and, preferably, without smoke, set the weak colonies having brood over strong ones. It will be necessary to give a frame of brood to each of the weak

[1] "A B C and X Y Z of Bee Culture," Root, 1910, pp. 284, 285. "Gleanings in Bee Culture," 1906, p. 423, or in "Alexander's Writings," published by the A. I. Root Company.

colonies having none. These may then be set upon strong colonies, in each case using a perforated zinc between the upper and lower hive, as before.

Alexander's caution is: "In every case where the method is reported a failure it has been from one of two causes, — either lack of brood in the weak colony, in order to hold the queen and her few bees in the upper hive, or smoking the strong colony so that, as soon as the weak one was set on top, the bees rush from below and sting every one above. Therefore, avoid using smoke or doing anything to excite the strong colony." The whole should be done so that neither colony realizes that it has been disturbed. In about thirty days each hive will be crowded with bees and maturing brood. Then, when you wish to separate them, set the strongest colony on the new stand.

A further spring duty is to clean up the apiary. As is explained under "Hygiene of the Apiary," on the first day that bees fly examine each hive and determine whether it contains a living colony. *Immediately,* close bee-tight any hive in which the colony has died; furthermore, remove the hives and contents to a bee-tight building. This is not only a wholesome practice to prevent robbing, but it is vital in order to check the spread of diseases. For a similar reason beekeepers are warned against *exposing any comb, honey or section* so that the "bees may clean it up," as is so thoughtlessly done.

Contraction of the entrance is a matter of judgment. As a general rule. never give more entrance than can be guarded by the bees within; this is especially applicable in spring and fall. Entrance contraction as is erroneously and frequently thought, is not of so much importance in controlling ventilation as in reducing or preventing robbing.

Weak colonies benefit in the early spring by being outwardly protected. Outside cases of wood or paper coverings, used as winter protection, are of much service in early spring, when a high temperature must be maintained for brood rearing..

Feeding.

Usually, bees can exist without being fed extra stores. There are advantages, however, in judicious feeding. This may be accomplished in different ways and for different purposes. At present, as a general rule, it is not safe to feed honey, there being too grave danger of transmitting brood disease by it. On the whole, sugar is not only safer and more preferable but cheaper. When necessary. honey may be *diluted* with an equal amount of water, *boiled one hour in a covered vessel* and fed.

Spring Feeding.

Usually, enough stores can be provided in the fall to last until a honey flow comes in the spring. Moreover, feeding is always stimulative to egg production and brood rearing. Consequently, when it is done in the spring a thin syrup made from the best granulated sugar, one part of sugar to two or even three parts of water, may be used. Small amounts, a pound or two daily, are usually sufficient.

Fall Feeding.

In the fall, the purpose being merely to supply winter stores, feeding is done as rapidly as possible. In considering the wintering problem, emphasis is placed on the necessity of ample and naturally stored supplies; therefore, feeding should be completed early in October. At this season there is no desire to stimulate, and a thick, saturated solution of granulated sugar is used.

How to Feed.

There are many devices on the market for feeding, most of them having merit and some particular convenience. They may be listed: Cary, Danzenbaker, Paige, division-board, pepperbox or Boardman (slow or small feeders), and Miller (a rapid feeder). These may be seen pictured in the catalogues. On the whole, an entrance feeder is to be avoided, since it excites robbing unless cautiously used.

Tin Pan Feeder.

This is perhaps the most satisfactory, inexpensive and sanitary feeder in use. A tin pan is filled with excelsior and placed in an empty super above the brood chamber. When filled with syrup, the excelsior affords a footing for the bees, so that few drown, drowning being an objection to some other feeders. Furthermore, dry sugar may be placed in the pan and merely dampened with water, supplying an excellent slow feed. When desired, the pans may be scalded and sterilized. There is no checking of the wood, nor breaking of glass; they telescope and pack away, and their cost is but 5 or 10 cents each.

Mixing Syrup.

Usually it is not necessary to boil syrup if mixed in advance and thoroughly stirred (an extractor is serviceable for 50 pounds or more of sugar). If hot water is used, it is an advantage. There are two precautions, however. Never feed scorched syrup, since it is fatal. There are cases, also, where feed has stood in galvanized tanks, as in an extractor, and has been found upon feeding to be poisonous to brood, especially in queen rearing.

Pollen Substitutes.

Whether we have yet found a substitute for pollen is a question. Some authorities advise placing bran, rye flour, pea flour and other similar materials where bees can gather them in the early spring. No objection or particular advantage in the practice has been observed.

Wintering.

One of the most formidable obstacles in the industry is wintering. Among those who practice the "let-alone" method of beekeeping, the mortality in winter and early spring is high. Unfortunately, no accurate studies of the best conditions for wintering have been made, yet failure may frequently be attributed to starvation, too small colonies as a result of late swarms, old queens which fail to survive or build up the colony in spring, or to the lack of a large population of young bees reared in the fall, which are to survive as workers the following spring.

Bees pass the winter in what may be termed a winter nest. They do not hibernate in the strict sense of the word, but cluster densely on the combs, maintain a relatively high and constant temperature, and consume honey for the purpose of heat production. Several months are sometimes passed without their leaving the hive, but upon the first calm warm day of spring, when the mercury reaches 45° to 50° F., they break clusters and fly forth, relieving themselves of excrement which they have retained rather than deposit in the hive. Having usually ceased brood rearing in October or early November, this is resumed in the spring, sometimes as early as February and usually in March.

Based on an understanding of normal conditions and behavior, it is evident that certain precautions by the beekeeper can materially further successful wintering. Perhaps the most important are plenty of provisions naturally arranged or stored early in the fall, and accessible to the cluster in winter; a large population of young, vigorous bees, reared late, which survive to become workers the following spring; a young prolific queen, preferably of the previous summer's rearing; and rational outward protection to the hive.

The methods of feeding are already discussed. This should not be delayed later than the first of October, to allow the natural and proper storage of the provisions. According to the size of the colony is the winter consumption. On the average, 35 pounds are consumed by colonies wintered out of doors, and bees, stores and hive fixtures should weigh approximately 50 pounds in the fall. Colonies light in naturally gathered provisions should be provided a balance of thick, fall-feeding, sugar syrup. Cellar-wintered colonies consume less than half as much provisions.

Normal, populous and provisioned colonies often do as well, or better, without packing and protecting. A common winter covering is the banking of a hive in straw, leaves or litter. An outer case, with an air space between it and the hive, has more merit. The air space is sometimes filled with insulating material, such as cork, shavings or chaff, but this practice is frequently considered by practical apiarists as the cause of too much condensation, and, consequently, dampening within the hive during long confinement. It must be recognized that within there is a living cluster of bees, actively transpiring and exhaling, which means that moisture is given off. If there is no escape it collects and runs down over the frames and bees. A cold night may later transform it into frost. The heat of the sun does not penetrate the excessive packing, thus there is refrigeration, rather than the desired conservation of heat. To be as near normal, natural conditions as possible, it would appear as though the much practiced and liked method of wrapping hives in paper is to be preferred. Newspapers, over which is laid a waterproof building paper (some prefer tar paper), are brought down and cleated to the hive in order to prevent blowing off. Through this by day the sun can warm and help dry out the hive, and at night the heat within is retained. If desired, previous to wrapping in paper an empty super may be set over the brood chamber. In this a sack of cork chips, dry leaves or shavings may be placed so as to act as an absorber for excessive moisture. Provision should be made, however, for the free passage of the bees over the tops of the frames and beneath the cushion by laying cleats crosswise on the frame top bars.

A common error is a too great contraction of the entrance, which results in retention of moisture and ultimate mildew or mold on the combs. A strong colony should have a full width (14 by ½ inch) entrance. Weaker colonies may profit by proportional contraction by means of blocks.

In some localities field mice cause considerable damage by building nests in the hives, gnawing and eating combs, pollen and dead bees. Access may easily be prevented by placing, early in the fall, a guard. composed of ½-inch mesh wire cloth, over the hive entrance, through which the bees pass readily.

Cellar wintering requires precision in care, some equipment and experience. In a large apiary Massachusetts beekeepers will benefit by successfully wintering 95 per cent. to 100 per cent. of their colonies. The cost of a cellar will soon be overbalanced by saving in stores consumed and in the loss of colonies sometimes attending outdoor wintering. Limited space and the fact that this paper is intended for smaller beekeepers suggest that details be consulted in "A B C and X Y Z of Bee Culture," Root, 1910.

Hygiene of the Apiary.

Brood Diseases of Bees.

American foul brood and European foul brood are the names of two distinct brood diseases of bees which until recently have had little consideration in Massachusetts, yet their prevalence is proved to be general, and to have caused inestimable losses to the beekeepers and horticulturists. No one problem in apiculture is more vitally important, and yet, when understood, the most gratifying results can be obtained by treatment. It is not a crime, as some have thought, to find colonies diseased. As conditions have been in Massachusetts, the presence of disease was expected almost anywhere. It should be considered more disgraceful to allow disease to remain unsuppressed, so great are the infection and damages. Moreover, it is being demonstrated for the first time in the Commonwealth that brood diseases can be checked, that the treatment is not so radical and burdensome as has often been feared, and that whole beekeeping communities are benefiting more than they had anticipated. The earnest co-operation of every beekeeper is solicited in the interest of promoting Massachusetts apiculture.

An adequate description of the diseases, how to tell them and how to treat them, could not be undertaken in this limited space. It may be said, however, that every beekeeper should examine his brood from time to time, especially in the early summer. Healthy brood in unsealed cells is of a pearly white color, and the larva, a grub or developing bee, is curled in the cell and plump. If you do not find this appearance, but there is a yellowish, grayish, brownish or blackish and more or less shapeless mass, decayed in the cells, or if the brood is irregular, the cappings discolored, sunken and perforated, there is reason to be suspicious. A colony which fails to build up, to hold its own, which does not respond to manipulation as it should, or one which dwindles early in the summer, affords reasons for being watched. The presence of the disease is not always apparent, unless a cell by cell examination is made.

The owner of bees should consider that it is his individual duty to watch and inspect his own colonies. While the State inspectors are endeavoring to visit the beekeeper, the progress of the work can be greatly furthered by the individual's efforts. Do not delay reporting to the State Inspector of Apiaries, Amherst, Mass., any case which is suspicious. A systematic effort will then be made, not only to assist the person so reporting and his neighbors, but to check and suppress the infection throughout the locality. In this way it has been possible already to clean up whole towns and even parts of counties.

If the reader has not obtained copies of the publications on this

subject, mentioned below, they will be sent gratis. They contain the information which beekeepers need in order to successfully combat brood diseases.[1]

General Hygiene.

In traveling among the beekeepers, the most urgent need for better sanitary conditions in the apiary have been found. This is not only true in districts where foul brood is being fought, but elsewhere, and even in the yards of beekeepers of long experience. This is partially due to the fact that it is no longer possible to practice some of the methods which were formerly considered wholesome and safe, and partially to the prevalence of diseases. Without attempting to elaborate, and, perhaps rather imperatively, but with the best intentions, the more important suggestions are made for bettering conditions in the apiary and in Massachusetts beekeeping: —

Try Italian stock.

Use a smoker and veil; own these.

Transfer colonies from box hives.

Keep down the weeds and grass in the apiary.

Try to keep your colonies strong always.

Use removable frames and do not nail these down.

Contract the entrances of any weak colonies.

Examine the brood in each colony at least two or three times in the early part of the season. Learn to look from cell to cell and into cells.

Keep only as many colonies as you can attend to.

The use of full sheets of foundation and wiring of the frames will be an advantage to most persons.

Immediately, as a colony is found dead, close the entrance and remove the hive to a bee-tight building.

Under no circumstances expose old combs, sections and the like where bees can visit them. There is no economy in it; there is danger of robbing and of disease.

Treat diseased colonies as soon as they are discovered. The longer the delay, the greater is the loss or labor.

Make sure that colonies have ample stores for winter. Give them early spring attention.

Scraps of wax, bits of combs, should never be left in the apiary or out of doors, not even for an hour or so. Have a covered box, can or barrel which is bee-tight and indoors. It pays to accumulate the wax.

A limited space unfortunately excludes some fundamental pro-

[1] "Brood Diseases of Bees, their Treatment and the Law for their Suppression in Massachusetts," Bulletin No. 1, Apiary Inspection, Massachusetts State Board of Agriculture. By Burton N. Gates, Ph.D., 1910. "The Treatment of Bee Diseases," United States Department of Agriculture, Farmers' Bulletin No. 442. By E. F. Phillips, Ph.D., 1911. A list of the other government publications on disease and bees may be found in the last-mentioned paper.

cedure which might rightfully find place in this bulletin, for which the beekeeper is referred to other publications.

"Swarm control," by no means satisfactorily settled, is, however, alluded to in the consideration of requeening. "Handling and hiving swarms" is rather generally understood and discussed in most books. The time for "taking off surplus honey" may be said to be as soon as the honey is sealed or capped; yet beekeepers have individual preferences. "Increasing the honey crop" would be a profitable subject for consideration. These and other subjects could well comprise a bulletin. "The Production and Care of Extracted Honey" is treated by Dr. E. F. Phillips, Bulletin No. 75, Part 1, Bureau of Entomology, United States Department of Agriculture. The reader is urged to secure federal bulletins and to consult books and periodicals on beekeeping.

List of Bee Books.

General.

Comstock, Anna Botsford: "How to keep Bees."

Langstroth, L. L.: "Hive and the Honey Bee," 1853 (original edition); recent revised editions by Dadant.

Miller, Dr. C. C.: "Fifty Years among the Bees."

Poetical, Literary and Historical.

Edwardes, Tickner: "The Lore of the Honey Bee."

Materlinck, Maurice: "The Hive of the Bee;" "The Swarm."

Morley, Margaret W.: "Bee People;" "Honey Makers."

Technical.

Root, E. R. and A. I.: "A B C and X Y Z of Bee Culture" (an encyclopedic work for specialists and experienced beekeepers, and the most comprehensive work in English).

Hutchinson, W. Z.: "Advanced Bee Culture."

Cheshire, Frank: "Bees and Beekeeping" (two volumes, practical and scientific, fast becoming out of date, but considered an important source book).

Von Buttel-Reepen, Dr. H.: "Are Bees Reflex Machines?" (translated from the German. All of this author's papers are exceedingly important from the scientific and even the practical standpoint).

Queen-rearing Papers.

Phillips, Dr. E. F.: "Queen Rearing," Bulletin No. 55, Bureau of Entomology, United States Department of Agriculture.

Doolittle, G. M.: "Scientific Queen Rearing."

Bee Journals.

"American Bee Journal," Chicago, Ill.
"Beekeepers' Review," Detroit, Mich.
"British Bee Journal," Covent Garden, London, W. C.
"Canadian Bee Journal," Brantford, Ontario, Can.
"Gleanings in Bee Culture," Medina, O.
"L'Apiculteur," published 28 Rue Serpente, Paris (VI^{e}).

TENTH ANNUAL REPORT

OF THE

STATE NURSERY INSPECTOR.

Presented to the Board and Accepted,
January 9, 1912.

TENTH ANNUAL REPORT OF THE STATE NURSERY INSPECTOR.

To the State Board of Agriculture.

I have the honor to submit herewith the tenth annual report of the State Nursery Inspector.

During the last few years the duties of the nursery inspector have changed greatly. Originally, the work was simply an examination by the inspector of the nursery stock found growing, and the removal of all insect pests and diseases discovered. This work increased rapidly as the nurseries grew in number and size, and in time other duties were added by legislative enactment. One of these additions was the inspection of plants outside of nurseries when their condition was such as to jeopardize the health of other plants on adjacent property. The law declared that such plants might be declared a public nuisance and prescribed methods for abatement, the whole of which was placed in the hands of the nursery inspector. Another addition was the requirement that every agent selling nursery stock should secure a license, and that has involved considerable extra time and correspondence. The law of 1909 also required that every shipment of nursery stock entering Massachusetts should be accompanied by a tag permit from the Massachusetts inspector, who was expected to satisfy himself, before issuing tags, that the stock to be sent into the State met our standards. The amount of time and the correspondence necessary to properly care for this portion of the inspector's duties was not known when this section of the law was passed. In fact, however, it requires a great deal of time and many letters, as the number of nurseries shipping into the State has proved to be very large, and the shipments numerous. Many nurserymen plan to satisfy Massachusetts requirements and purchase tags enough in the fall to provide for both their fall and spring shipments, but last spring, notwithstanding this practice, 6,177

tags, and this fall 18,780 more, were sold, which indicates the extensive business done in Massachusetts by the nurserymen of other States.

The danger of the introduction, on importations of stock from abroad, of pests and diseases not now present in this State, is a very real one and has been constantly kept in mind. Until recently, however, it has been impossible to learn of the receipt of imports, and therefore nothing like a general examination of them could be made. For the last year or two, through the kindness of the United States Department of Agriculture, regular statements of all shipments of nursery stock into Massachusetts from abroad have been received from the various ports of entry, making it possible to examine this stock before any pests or diseases it might harbor should be able to escape and establish themselves. These imports of nursery stock are very numerous, there having been 4,964 separate packages during the year 1911, many of which contained hundreds and even thousands of plants, each of which requires examination.

During the last three years the gypsy and brown-tail moths have invaded practically every nursery in eastern Massachusetts. This has necessitated the most careful and thorough inspection of all these places after the 10th of September, as until that date the insects might enter the nursery from outside, after the inspector had completed his work. In the case of many varieties of stock, the presence of these pests cannot be conclusively settled until after the leaves have fallen, so that unless all business of the nurseries be stopped till the middle or end of October, some other method of supervision becomes necessary. This has been solved by placing inspectors at different points, with instructions to examine every plant shipped from nurseries within the territories assigned to them, and when found clean to issue certificates for those particular shipments, leaving inspection of the nurseries as a whole, for these pests, until after the leaves had fallen, thus permitting the nurserymen to carry on their business during the fall without waiting until their entire nurseries could be inspected.

The statements just presented show in outline how much the work of nursery inspection has increased and changed during the last ten years. Yet during this time the appropriation, originally $1,000, has been increased to $2,000 only. Realizing

the impossibility of doing even a small portion of the work with this sum, the Massachusetts Nurserymen's Association last winter presented a bill to the Legislature, asking for $25,000 for the various inspection purposes. It was stated at the hearings that some parts of the work had never been carried out for lack of funds, and the amounts needed could only be guessed at. The Legislature recognized this and did not pass the bill as such, but incorporated its provisions in a resolve carrying $10,000, to expend such a portion thereof as might be necessary, to give definite data from which to present a bill to the Legislature of 1912. With this sum, therefore, added to the regular appropriation of $2,000, the work has been carried on the past season.

Inspection is sharply divided into two types of work. In one, the inspectors must be thoroughly familiar with all the dangerous insects, large and small, and with the diseases liable to be present on nursery stock which, if sent out or even allowed to remain in the nursery, might spread destruction through the region where they occur. Men competent to do this work must have had special training in entomology and vegetable pathology, and such men are in demand at salaries from $1,500 to $3,000 a year. It is difficult to obtain and hold such persons for more than a year or two before some permanent opening at a good salary draws them elsewhere; but thus far, by taking men who have not entirely completed their studies in these lines, they have been found. They have devoted their attention mainly to the more critical examination of the stock, the inspection of places claimed to be public nuisances, and especially to the examination of imports where unknown foes might be present, where their special training was of great value in recognizing injuries caused by pests and diseases just arriving from abroad.

The other class of inspectors consists of men who know the gypsy and brown-tail moths in their different stages, but have not the training necessary for the other class of work. To find reliable men enough to thoroughly cover more than 1,500 acres of nursery stock, after the leaves had fallen and before winter should stop the work, was a problem which was finally solved through the co-operation of Mr. D. M. Rogers of the United States Department of Agriculture, in charge of the gypsy moth

work in New England, who loaned 35 of his best men for the purpose, and who in many other ways has aided in the inspection, besides showing great interest and sympathy with the work.

During the inspection the past season, 149 places, the property of 140 different owners, were visited. Some of these were known to be agents, but in such cases it was certain that they had stock on hand for sale which might be infested, and which it was therefore necessary to examine, to make sure it should not be sold unless in proper condition. A number of new nurseries have been established, and most of the older ones have increased their acreage. It is a pleasure to state that as a whole the nurseries of the State are in better condition than ever before, both as regards general condition and freedom from insect pests, except for the gypsy and brown-tail moths. With reference to these pests, the nurseries were not in as good condition as heretofore, in some cases, but this is due to the fact that they have reached and entered the nurseries from surrounding territory, for the first time since the inspection last year. The power placed in the hands of the inspector by law, to require owners of land adjoining nurseries to clear those lands of the gypsy and brown-tail moths, has frequently been made use of the past season, and the establishment and maintenance of such free zones around the nurseries should mean greater freedom from infestation from outside hereafter.

The cost of the inspection work during 1911 is now available as a basis upon which to estimate what will be needed hereafter. Unfortunately, the resolve enacted by the last Legislature did not pass until after all the spring imports had been received, and the cost of the spring work is therefore still unknown. Estimating this on the basis of the number of imports, however, and on the time required per average shipment, it would seem that an appropriation of $15,000 would just about meet the annual cost of the various lines of work required by law.

The resolve carrying the appropriation under which the work has been conducted is not a continuing one, and it therefore seems desirable to incorporate its provisions and the needed appropriation in a bill to be presented to the incoming Legislature, and I accordingly recommend this. A careful examination of the present condition of the nursery inspection laws leads me to the opinion that this can best be done, not in the

form of amendments to the present law, but as a new law, including what it is desirable to preserve of chapter 444 of the Acts of 1909 and also of chapter 103 of Resolves of 1911, and a draft of such a law has been prepared and is now in the hands of the secretary.

FINANCIAL STATEMENT.

Appropriation (by resolve),	$10,000 00	
Appropriation (annual),	2,000 00	
		$12,000 00
Compensations of inspectors,	$3,332 50	
Traveling and necessary expenses,	2,773 16	
Expenses of inspectors engaged in gypsy moth work, salaries paid by United States,	3,600 86	
Supplies (postage, printing, etc.),	79 21	
Clerical services,	25 00	
Salary of chief inspector,	220 83	
		10,031 56
Unexpended balance,		$1,968 44

Nearly all of the details of the field work of the season, together with the supervision of the men on the work, has been in charge of Deputy W. S. Regan, to whose skill and supervision the success achieved has been due, and it is only fitting that this should be recognized here. To the secretary of the Board is due the statement that his interest in the work has been manifested in many and most effective ways, and is much appreciated.

A list of the nurserymen of Massachusetts, Dec. 1, 1911, is appended.

Respectfully submitted,

H. T. FERNALD,

State Nursery Inspector.

APPENDIX.

List of Nurserymen in Massachusetts, Dec. 1, 1911.

Adams, J. W. & Co., Springfield.
Agawam Nurseries, Agawam.
American Forestry Company (T. F. Borst), South Framingham.
Anderson, Wm. L., Lakeville.
Arnold Arboretum, Forest Hills.
Atkins, P. A., Pleasant Lake.
Atwater, C. W., Agawam.

Barrett, M. W., Hyde Park.
Barrows, Henry H. & Son, Whitman.
Barrows, H. E., Brockton.
Bay State Nurseries (W. H. Wyman), North Abington.
Bemis, A. L., Worcester.
Bloomingdale Nurseries (James E. Draper), Worcester.
Blue Hill Nurseries (Julius Heurlein), South Braintree.
Boston & Maine Nurseries (D. J. Desmond), Reading.
Brandley, James, Walpole.
Breed, E. W., Clinton.
Briggs, L. H., Smith's Ferry.

Canning, E. J., Nursery Company, Northampton.
Carr, Chas. E., Dighton.
Casey, C., Melrose.
Chaffee Brothers, Oxford.
Chase, Joseph S., Malden.
Clapp, E. B., Dorchester.
Clark, G. Aldersey, Waltham.
Comley, Norris F., Lexington.
Concord Nurseries (H. M. Pratt), Concord.
Continental Nurseries (A. VanLeeuwen), Franklin.
Coskery, Elmer, Newburyport.
Cutler, Mary E., Holliston.

Davenport, Alfred M., Watertown.
Davenport, S. Lothrop, North Grafton.
Davis, Peter & Son, Fairhaven.

Dighton Nursery Company (J. S. Place), Dighton.
Dove, Paul, Wellesley.
Dwyer, E. F. & Son, Lynn.

Eastern Nurseries, Holliston.
Elliott, W. H., Brighton.

Farquhar, R. and J. & Co., Roslindale.
Field, H. W., Northampton.
Follansbee's Nurseries, Haggetts Pond, Andover.
Ford, J. P., East Weymouth.
Framingham Nurseries (W. H. Wyman), South Framingham.
Franklin Park Nursery (J. A. Pettigrew), Jamaica Plain.
Frost, G. Howard, West Newton.

Gates, W. A., Needham.
Geer, J. T., Three Rivers.
Gilbert, A. L., Springfield.
Gordon, A. B., Randolph.
Gormley, Edw. W., Jamaica Plain.
Gowing, J. D., North Reading.
Gregory, J. J. H. & Son, Middleton.

Haendler, M. P., South Natick.
Hayes, John L., Nursery Company, Bellingham.
Horne, H. J. & Co., Haverhill.
Howard, J. W., Somerville.
Huebner, H., Groton.

Jahn, H. A., New Bedford.
Jennison, W. E., Natick.

Keen, Cyrus R., Cohasset.
Keizer, H. B., Reading.
Kelsey, H. P., Salem.
King, R. B., Nantucket.

Langdell, R. S., Spencer.
Lawrence, H. V., Falmouth.
Leuthy, A., Roslindale.
Lister, James, Newburyport.
Littlefield, H. B., Worcester.
Littlefield & Wyman, North Abington.

MacGregor, James, Braintree.
MacMannon, J. J., Lowell.
Mann, H. W., Stoughton.

Margeson, Ingram I., Westwood.
Massachusetts Highway Commission (E. W. Breed), South Lancaster.
Matthews, Nathan, Hamilton.
McCormack, J. J., Malden.
McKenzie, John, North Cambridge.
McMulkin, E., Norfolk Downs.
Mead, H. O., Lunenburg.
Merritt, Charles L., South Weymouth.
Miller, W. & Sons, Lynn.
Moseley, F. S., Newburyport.
Murry, Peter, Fairhaven.

Neil, Sam, Dorchester.
Newell, C. F., West Newbury.
New England Nurseries (A. E. Robinson), Bedford.
Newton Cemetery Corporation, Newton.

Old Colony Nurseries (T. R. Watson), Plymouth.
Oxford Nursery Company, Oxford.

Palmer, F. E., Brookline.
Payne, Wm. H., Newtonville.
Payson, Edw., Lexington.
Peirce, C., Dighton.
Phelps, F. H., Lee.
Pierce Nursery Company, Beverly Farms.
Pomeroy, Edw. W., Gloucester.
Pratt, Chas. S., Reading.
Pulsifer, C. Y., Gloucester.

Quinn, Jas., Brookline.

Rawson, W. W., Arlington.
Rea, F. J., Norwood.
Reading & Floramead Nurseries (J. Woodward Manning), North Wilmington.
Rice, C. G. (F. A. Smith, superintendent), Ipswich.
Richards, C. A., Greenfield.
Richards, J. E., Needham.
Richmond Nurseries (Henry J. Lamke), Pittsfield.
Riley, Chas. N., New Bedford.
Robinson, D. A., Everett.
Robinson, L. D., Springfield.

Sawyer, F. P., Clinton.
Shaw, Frank H., Rockland.
Shirley & Fowle, Danvers.

Smith, George N., Newton Lower Falls.
Southwick Nurseries (Edw. Gillett), Southwick.
Southworth Brothers, Beverly.
Spinney, F. W., Haverhill.
State Forestry Department (F. W. Rane), Boston.
Story, A. T. & Co., Taunton.
Sullivan & McGrath, Dorchester.
Sylvester, G. F., Hanover.
Sylvia, M. B., New Bedford.

Tailby, Jos. & Son, Wellesley.
Tebbetts, C. H., East Walpole.
Thurlow, T. C. & Son, West Newbury.
Tuttle, A. M., Melrose Highlands.
Twomey, M. T., Franklin.

VanLeeuwen, Worcester.

Walsh, M. H., Woods Hole.
Walters, C., Roslindale.
Warren, Samuel J., Weston.
Wellesley Nurseries, Wellesley.
West Side Nurseries (C. R. Fish), Worcester.
Westwood Nurseries (Anthony McLaren), Westwood.
Wheaton, Frederick G., South Easton.
Wheeler, Wilfrid, Concord.
White, A. T., New Bedford.
Whittet & Co., Lowell.
Wood, Edward, Lexington.
Wright, G. B., Chelmsford.

Yetter, F. J., Greenfield.

FOURTH ANNUAL REPORT

OF THE

STATE ORNITHOLOGIST.

SYNOPSIS PRESENTED TO THE BOARD AND ACCEPTED,
JANUARY 9, 1912.

RIVER DUCKS AND SWANS.

This shows how wild fowl may be attracted to ponds, even in cities, where they are protected. Black ducks on the ice; two baldpates among the tame mallards; two American coots and one ruddy duck swimming near the edge of the ice. (Photograph taken by Charlesworth Levey at Jamaica Pond, Boston, Dec. 10, 1910.) (From the "History of Game Birds, Wild-fowl and Shore Birds.")

FOURTH ANNUAL REPORT OF THE STATE ORNITHOLOGIST.

The Work of the Year.

Educational Work.

It was expected, as stated in my last annual report, that a voluminous report on wild fowl, game birds and shore birds would be printed during the latter part of the year 1911. The overwhelming mass of material collected increased the size of the volume and extended the time necessary for preparing and printing it; but probably it will be published before this report reaches the public. It will make a volume of more than 600 pages, fully illustrated, and will be distributed to all the public libraries and the principal high schools of the Commonwealth. The copies remaining after this distribution will be sold at a price sufficient to cover the cost of printing. They may be obtained of the secretary of the State Board of Agriculture at Room 136, State House, Boston.

This work covers ground not embodied in any other volume. It comprises a collective history of the birds which are hunted for food or sport, their former abundance, their subsequent and continued decrease in numbers, a description and history of each of the species now extant, and descriptions and histories of those that have become extinct since the country was settled. The latter part of the volume is devoted in part to an enumeration of the causes of decrease and extinction, and in part to an exposition of the means of conserving those that are still with us.

The demand for free lectures has been met so far as it lay within my power without neglecting other important work. Forty-two lectures and talks have been given during the year,

most of which were illustrated by stereopticon. The audiences aggregated about 8,600 people and consisted largely of farmers and their families.

In Shrewsbury and Northborough, contiguous towns in Worcester County where addresses were given, public-spirited citizens offered prizes to the children of the townspeople for bird houses and essays concerning them. Prizes were given for the largest number of bird houses built by one child, and for the best built bird houses, and these prizes resulted in the building of hundreds of nesting boxes in these two towns. Some of the manual training schools now include in their curriculums instructions in making bird houses and nesting boxes, and all should do so.

Bird protection is so important that it would be well to have a bird day in our schools with appropriate exercises, which might include the erection of bird houses.

Educational work done by the State Ornithologist and by others interested in the protection of birds already has created a great demand for information regarding methods of attracting birds about the home and farm. Large numbers of letters have been received asking information about bird houses, feeding birds and attracting them. Such letters have come not only from Massachusetts but from other New England States, and from the middle and western States also. It is evident that State ornithologists are needed in some of the States where they are not yet established. Nature Leaflets Nos. 12, 15 and 16, issued by the Massachusetts State Board of Agriculture, have been utilized in answering queries. No. 12 takes up the methods of attracting winter birds to the farm, No. 15 is the Bird-House Leaflet, and No. 16 is entitled "Our Friend the Chickadee."

Many people have taken up the pastime of feeding birds this year for the first time, and many letters have been received from both children and adults giving something of their experience. The following letter from Mr. George M. Pedrick of North Beverly shows how easily and quickly birds may be attracted about the house in winter by using right methods: —

Mr. E. H. Forbush.

Dear Sir: — I have read for the third time your Nature Leaflet No. 12, from the State Board of Agriculture, and have put into practice some of its suggestions. Have tied in three places on trees large ham bones, nailed a large box about 8 feet up on the side of a tree, and filled it with gravel and fine sand; then spread large patches of hayseed around the yard and put on the clothesline posts a box filled with grain, and a firkin cover on the ground with more grain, and a dish of water. We have been highly entertained by the birds that have come to the feast. Six blue jays came, beauties, and the way they would strike their bills into that suet and hop in and out of that box was pleasing; a meadow lark was here again this A.M., fat and lively; and a flicker, going all over a large elm and getting his fill of something to his liking; a chickadee, as lively as a cricket, snatching pieces of suet and flying off, only to return for another bit; a downy woodpecker, going all over the lower part of the apple tree and taking his piece of suet when he needs it, and about 50 juncos and tree sparrows, here all day long, at one or the other of the feeds we put out for them. Mrs. Pedrick pounded up some crackers and put that out for them, and they ate that up clean; and, last, the old crow has come to have a little suet, but there is a field of sweet corn in shock near us and about 10 have had a feast there, so we make him keep off. Well, we have been kept busy watching all these visitors, and they have paid us for all our work and made us forget the snow and drear of winter, and it makes us think of spring and the singing of birds and the music of the brooks free from winter's grip.

I was going to make some houses for the birds, but I have mislaid the book from the State Board that had directions about them. We have Chapman's "Bird Life" and we think it fine, and spend many hours studying about the birds, for we are lovers of all animals and rarely kill even a snake. My belief is that they pay for their keep a good many times over. We have a number of deer around here and lots of pheasants, but they are very shy and keep to the woods mostly. We have a nice pair of Lemaire field glasses, so that we are able to see all these friends very clearly.

Thinking you would like to know how some of your suggestions work out, I was tempted to write you these facts.

Very kindly yours,

George M. Pedrick.

Jan. 19, 1912.

Many people who have put up bird houses, following the directions contained in these leaflets, have been very successful in attracting birds. Mr. Edward L. Parker writes that while two men were balancing a bird house on a pole and setting it up six tree swallows appeared, and one of them went into the house before the pole had been set firmly into the ground. Several of these birds nested in the bird houses which he put up. His son, Mr. James G. Parker, sends me a photograph of some flowerpots nailed to a board which was fastened upon one of the trees. A hole was knocked in the bottom of each flowerpot to allow the entrance of the birds, and in the spring of 1911 all were occupied by tree swallows or bluebirds. This is unusual, but it indicates a way in which any one may attract birds with very little expense.

Mr. R. L. Shewell of Milton was anxious to secure a family of bluebirds. He built a box according to my directions and nailed it on to a post on his fence. A pair of bluebirds took it and reared a brood. A reproduction of a photograph of this box with the bluebird on it is introduced here to show the situation and shape of the box. The entrance hole is 1½ inches in diameter.

Mrs. E. O. Marshall, secretary of the Massachusetts State Grange Committee on the Protection of Wild Birds, has sent out to many people the following circular letter, which has had much influence for good: —

To whom it may concern.

We are glad to inform you what sport we are having with birds, as *you* might get more or less enjoyment in some such way.

Some people have noticed that too many birds pass on, at migrating time, leaving strangely few to nest on their grounds.

In driving through the country, especially after the leaves are off in autumn, you may notice many nests in some localities where the food supply does not seem to be better than where nests are scarce. Just notice nests. Make a nest census on your grounds every year. It is educational and also sport.

Birds want *safe* places to nest. Von Berlepsch says that birds look long and earnestly for safe nesting places. They also must have a near food supply.

With us, the summer of 1910 was disappointing. The hole-nesting birds did not seem to approve our nesting boxes, and the open-nesting birds did not stay to build nests.

Last summer, *as soon as the first robins appeared,* the family cat was kept in the shed, other cats were watched and warned. The few other enemies to nests were watched and appropriately treated. Crumbs were scattered on rocks and bare places.

Where the year before only one robin's nest could be found, 21 robins' nests were counted. Forty other birds' nests were found in the same area, where very few were the year before.

Robins watch and defend their nests vigorously from enemies, so the little birds like to build near robins. For instance, a robin angrily drove off a jay, as soon as it appeared in sight of the robin's nest. The jays left that vicinity from that day. So many little nests were saved by one robin. Probably we are greatly in need of robins' help for defense of this kind.

One hundred and twenty-two birds and their young on a few acres nearest the house make the country interesting.

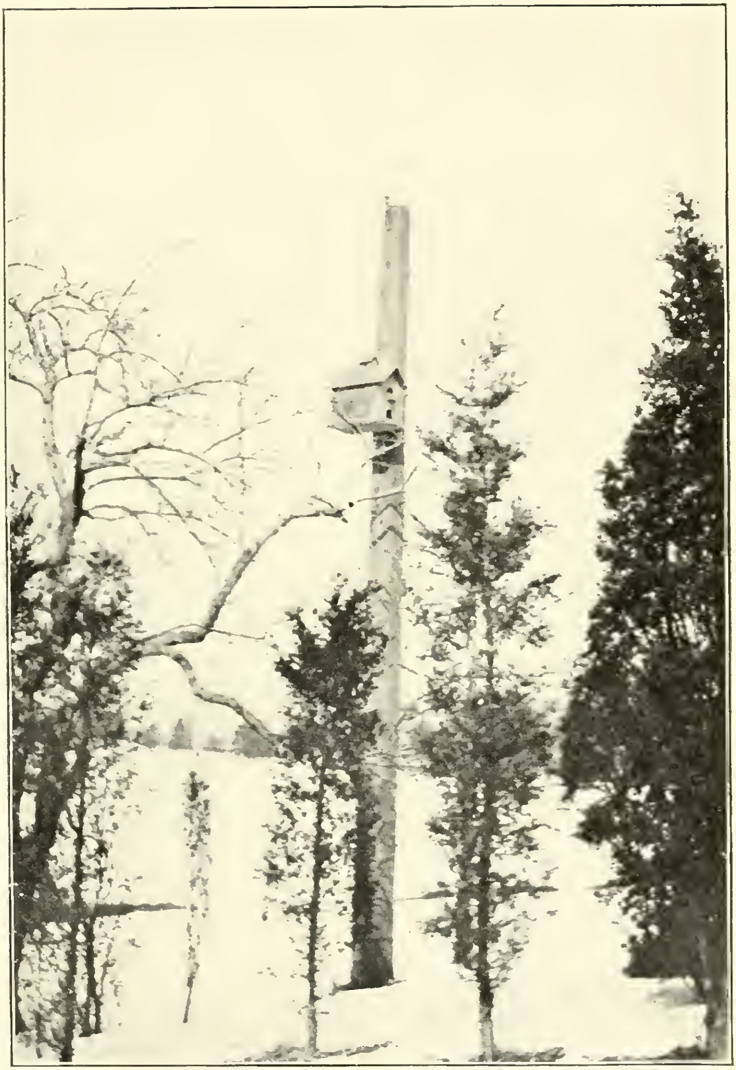
Elm-leaf beetles are not troubling our trees, and we have no brown-tail moths this spring. Perhaps that, however, is because we hang out suet for woodpeckers in winter and attract them. That is another story.

It was my intention, as noted in my annual report for 1910, to attempt to colonize a large number of birds in some tract infested by the gypsy moth and the brown-tail moth and to report the result; but the Commissioners on Fisheries and Game asked the Legislature of 1911 to authorize them to undertake a similar work, and their petition was granted. Under the circumstances it seemed best not to duplicate that work in this department, but rather to encourage individuals to colonize birds on their own estates. Many people in most of the counties of the Commonwealth are now experimenting in this way. Hon. John E. Thayer of Lancaster, Mass., has put up many nesting boxes, destroyed the enemies of the birds, and driven out the English sparrows, with splendid results. He says that he never has had so many birds as now remain to nest, although he sprays his trees. Mr. Wm. H. Browning has put up about 200 nesting boxes of the Von Berlepsch pattern at his place at Rye, Long Island, N. Y., most of which have been occupied by birds. Mr. Horatio Hathaway and some of his neighbors in Dedham, Dr. John C. Phillips of Wenham, and Mr. William P. Wharton of Groton are experimenting with the Von Berlepsch nesting boxes, and Mr. Wharton has planted shelter thickets after the Von Berlepsch plan.

Recent attempts to provide acceptable domiciles for the great-crested flycatcher have proved successful. Mr. William Brewster at Concord fastened in an apple tree a section of a hollow limb prepared especially for the bird, and it was utilized. Mrs. J. W. Elliot states that at her home at Needham, Mass., a pair of these flycatchers occupied, in 1909, a bird house on a telephone pole; in 1910 a Duryea starch box situated rather high up in an apple tree; and in 1911 a similar starch box on a pole fastened to a rose trellis, and only about 8 feet from the ground. The first and last nesting boxes are shown in the accompanying illustrations, which are taken from Mrs. Elliot's photographs. The situation and shape of the nesting box seem to be immaterial to this flycatcher, but in all cases the entrance was large, — more than 2 inches in width. These are the first instances known to me in which this species has occupied nesting boxes in Massachusetts.

Birds interest the People.

The interest that people of all classes evince in bird life is not generally appreciated. In the winter of 1910–11 a barred owl spent several weeks about City Hall Park, Boston. During these weeks the sidewalks and the park were crowded day after day with people watching the bird, although it slept through most of the daylight hours in one of the large trees. In November and December, 1909, flocks of robins appeared in all the New England States. They were noted first in Maine, and were seen soon afterward in southern New Hampshire, Massachusetts, Rhode Island and Connecticut. All through January the robins were present in numbers. The newspapers recorded the flight, and many letters regarding it were received from many parts of eastern Massachusetts, from Worcester to the coast, and from northern Essex County to the end of Cape Cod; large flocks were reported from the island of Martha's Vineyard. They penetrated into the interior beyond Worcester, and everywhere this unusual flight of robins at this season was a topic of conversation among the people. The mild weather of the early winter, the lack of snow in some of the northern regions,



Bird house first used by the great-crested flycatcher at the home of Mrs. J. W. Elliot at Needham. (Photograph obtained through the courtesy of Mrs. Elliot. See page 190.)

Nesting box used the second season by great-crested flycatcher. (Photograph by courtesy of Mrs. Elliot. See page 190.)

and a large crop of winter berries made conditions favorable for the robins in New England and farther north. The comparatively mild weather of the fall and early winter encouraged some bluebirds to remain. A few usually winter in Rhode Island and Connecticut, and reports from eastern Massachusetts seem to indicate that some wintered here during the season of 1910–11. There were still a few bluebirds in the New England States up to Jan. 1, 1912, as they were observed in the several localities in eastern Massachusetts during the latter part of December.

A Flight of Egrets in Massachusetts.

One feature of the summer of 1911 which attracted the attention of very many people was a flight of egrets (*Herodias egretta*) which remained here for parts at least of two months. The American egret is the larger of the white herons, the plumes of which have been sought by milliners for many years. In North America the birds have been almost exterminated by the plume hunters, and they are disappearing in South America for the same reason. Similar species are fast becoming extinct in India, China and other countries from the same cause.

White herons were reported in July from Plymouth and Barnstable counties, and correspondents from nearly all the eastern counties noted their appearance later. It has been many years since more than a single bird has been seen and recorded within the limits of Massachusetts. They were first noted after the middle of July in Plymouth County and later in Barnstable, Middlesex and Essex counties. Mr. Edward R. Farrar saw one in Lincoln through the latter part of July, and until the 18th of August. All the other cases were reported from localities near the coast. Eastham, Halifax, Plymouth, Wareham, Scituate, Marshfield, Ipswich and Rowley were some of the towns in which the species was reported. Mr. A. B. Fowler saw one first at Ipswich July 30. August 8 another appeared, which disappeared on the 12th and came back on the 14th. July 29 Mr. Robert O. Morris saw one between Ipswich and Newburyport. Four were shot

during the summer. Three of the shooters were arrested and fined, and in one of these cases the judge said he regretted that he could not send the lawbreaker to jail for six months. One of the shooters had a permit for collecting birds for scientific purposes.

As many as 6 egrets were seen in one locality (Eastham), and as the birds remained for a considerable time wherever they were not disturbed, going only a short distance from their feeding places to their roosting places, and as individuals were seen at the same hour in different towns and counties, it is probable that there were more than a dozen birds, and perhaps 20, in eastern Massachusetts in 1911. Egrets formerly were found in considerable numbers in the southern States and in the greater part of the United States as far north as New York and New England. They have become very rare within the last fifty years, on account of the great demand for their plumes. The occurrence of these birds in Massachusetts must be attributed largely to the success of the National Association of Audubon Societies in protecting from the depredations of the plume hunters a few small heronries in the south Atlantic States. Herons wander about the country at the close of the breeding season before beginning their southward migration, and as they sometimes go long distances to the northward it seems probable that these birds which passed part of the summer in Massachusetts were wanderers from southern heronries.

Birds feeding on Gypsy Moths and Brown-tail Moths.

During the winter of 1910–11 there was a small flight of evening grosbeaks, rare and beautiful birds, which apparently have only recently begun to come to Massachusetts. They were reported from various towns, particularly in Worcester County, and also from other New England States. They have been observed feeding on rose seeds by Carl H. Manning of Southborough, and Mrs. Ella E. Horr of Worcester writes that Mr. C. K. Reed watched a small flock feeding on the estate of Mr. Henry Brannon of Worcester. People who observed these birds in Worcester state that they were

feeding on brown-tail moths and were doing very effective work destroying the nests of these moths on tree after tree.

Reports from New Hampshire indicate that large flocks of grackles fed on brown-tail caterpillars during the fall of 1911. At that time the young caterpillars were in their webs.

Dr. Albert H. Tuttle makes the following statement regarding the destruction of gypsy moth eggs by birds at his place in Billerica, Mass.: —

> Last fall (1911) the boy was trapping skunks. We took the carcasses, hung them up on the trees around the camp, and added some suet and mutton fat from time to time. The downy woodpeckers and chickadees were there all winter long. Nest after nest of the gypsy moth eggs was absolutely cleaned out. Some nests were only partly destroyed. The birds destroyed two-thirds of the eggs that were on the estate. The downy woodpeckers have done most of it.

Thus far there is no evidence that the destruction of the eggs of this moth by birds has become general, but it is encouraging to note that the taste for them is increasing.

The English Sparrow.

The so-called English sparrow which has been regarded as a pest, and which certainly is more injurious and less beneficial than most native American birds, already has many friends in this country. It must necessarily have some beneficial habits, for practically all land birds destroy pests of some kind. Mr. W. G. L. George of Amesbury, Mass., writes that the sparrow eats more brown-tail moths than any other bird that he knows of. It is a well-known fact that this bird eats both the imagoes and larvæ of this insect. Mr. George states that four years ago a large elm tree near his house was infested with "cankerworms." Two pairs of sparrows were rearing their young near by at the time, and Mr. George says that these two families of birds cleaned out the pests completely. He watched the operation from beginning to end. Few people may now remember that this sparrow was introduced for the special purpose of ridding the elms in parks of the geometrid caterpillars, — a service which they

undoubtedly perform. Native birds, however, might have done as well or better had the sparrow been left in its native home, and had they been encouraged to nest in the parks, for practically all native birds eat these insects.

Many people have complained during the year that the sparrow has driven native birds from nesting boxes, and two cases have been reported where the sparrow has dragged the young of other birds out of nests and killed them. A great manufacturing firm writes: —

> The sparrows have become so numerous about our buildings as to be almost unbearable so far as noise is concerned. Also they are extremely dirty and we are very desirous of keeping them away. It has occurred to us that poisoned food of some sort could be used with safety. May we not hear a word from you? If poison is proper, how shall we proceed?

Many inquiries similar to this have been received. Most of these inquirers have been referred to Farmer's Bulletin 389, published by the Bureau of Biological Survey, Department of Agriculture, entitled "The English Sparrow as a Pest," and Farmer's Bulletin 493, issued by the same bureau, on "How to destroy English Sparrows."

The old-time question as to whether the English sparrow is a pest or not continually comes up. The sparrow rears many young, and as the young are fed to a considerable extent on insects they consume quantities of insects in a summer. Should the sparrows in our city parks be destroyed, probably we should have serious trouble with leaf-eating insects, before native birds could be attracted to these parks in any numbers. Few native birds will come into the parks and nest there while the sparrow remains. The greatest injury done by the sparrow, therefore, results from the displacement of native birds and a consequent increase of insects which the sparrow does not eat. The leopard moth, for example, which was introduced into this country in the latter part of the last century, has become very destructive in cities. The control of this insect is very difficult and expensive, as it is a borer and cannot be reached by sprays of

any kind, as it remains most of the time within the wood. Apparently the sparrows do not disturb it, and where they are numerous and native birds are, therefore, scarce, this moth is very injurious, particularly in and around Boston, New York and other large cities. When the moth spreads out into the country, where woodpeckers and other native birds are numerous, it has, thus far, made no headway. Woodpeckers dig into the burrows where the larvæ hide, and

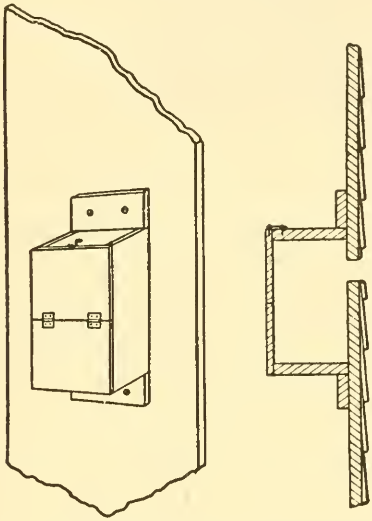


FIG. 1.—Perspective and sectional drawings of an improvised nest box for the interior of buildings. (After Biological Survey.)

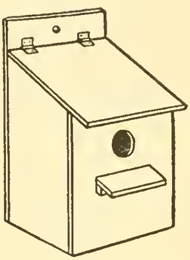


FIG. 2.—Nest box opening at the top. (After Biological Survey.)

other birds catch the larva when it leaves the branch or tree and crawls about on the bark. Had we kept out the sparrow and instead encouraged and attracted native birds into our cities the leopard moth might have been checked with little expense.

The sparrow, however, has many friends who seem to believe that it does no harm whatever. To those who see only one side of the case, I would recommend the various publications on the sparrow, several volumes of which have been published. Chief among these is Bulletin No. 1 of the Division of Economic Ornithology and Mammalogy of the United

States Department of Agriculture, entitled the "English Sparrow in North America," a work of more than 500 pages. In this bulletin, which was regarded at the time as "the most important treatise ever published upon the economic relations of any bird," evidence regarding the habits and the

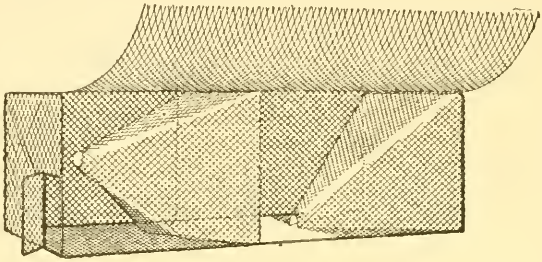


Fig. 3.—Funnel trap. Side raised to show interior. (After Biological Survey.)

destructiveness of the sparrow was brought together from all parts of the United States, and from Europe and Australia. The evidence against the sparrow from all these countries is overwhelming. Baron von Berlepsch, who has established the most successful European experiment station for the pro-

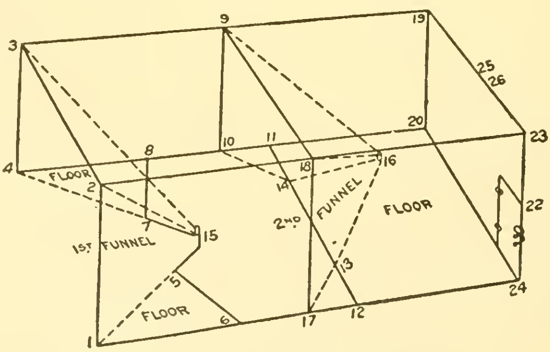


Fig. 4.—Outline of funnel trap. (After Biological Survey.)

tection of birds, conserves practically all small land birds; but finds it necessary to destroy this sparrow in order to give the other birds a chance. No American State protects the sparrow, but it is protected everywhere by its friends, and it flourishes particularly in cities and villages where shooting is not permitted.

For the benefit of those who wish to destroy sparrows about their own homes some of the latest devices for entrapping these birds are given below as published in the bulletins of the Biological Survey. Where sparrows occupy a nesting box put up for other birds, the box may be so arranged that the sparrows may be kept out, trapped or driven out. A box having an entrance not over an inch in diameter will admit house wrens and keep out sparrows; but if the entrance is large enough for any bird larger than the house wren, the

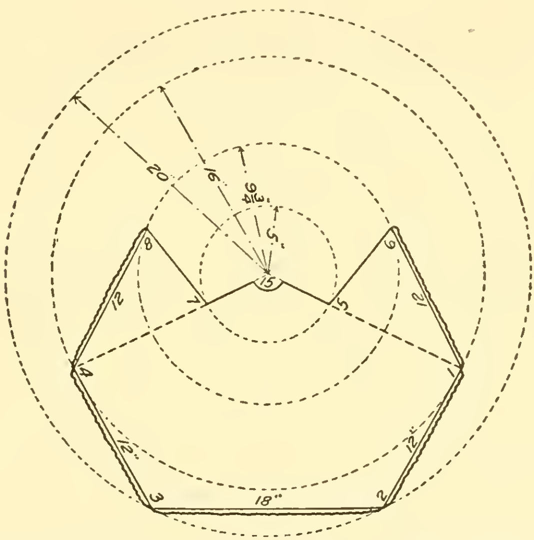


Fig. 5.—Pattern for first funnel of a trap to be 36 by 18 by 12 inches. (After Biological Survey.)

sparrow can get in. As sparrows begin nesting earlier in the spring than most other birds they may be driven from a nesting box early in the year by removing the nesting material from the box several times a week. For this purpose the box must be easily accessible and must have an opening by means of which the nest may be taken out with little trouble. Fig. 1 shows how such a box may be attached to the inner wall of a barn or other building, where it may be quickly opened from within the building and the nesting material removed; or a box, having a projecting cover which

will shut out rain, may be put up on a pole or tree. Such a box is shown in Fig. 2.

There are many contrivances for catching sparrows on the nest, some of which are given in the bulletins of the Biological Survey hereinbefore cited. There are successful devices for trapping sparrows, also, which are illustrated in Farmer's Bulletin 383. The simplest of these is the wire funnel trap perfected by Dr. A. K. Fisher of the Biological Survey. Fig. 3 shows the trap and Figs. 5 and 6 give details of con-

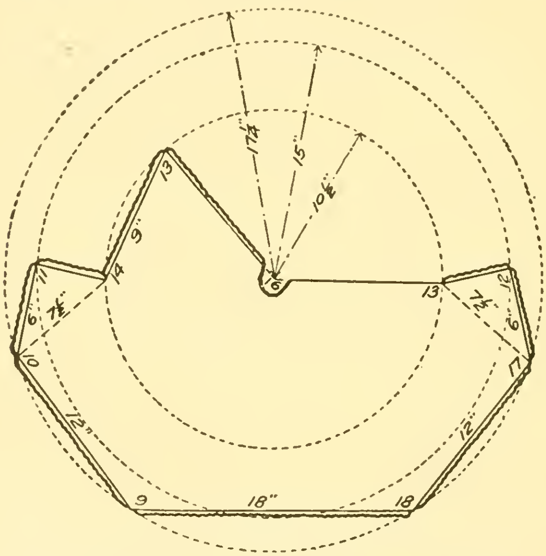


Fig. 6.—Pattern for second funnel of a trap to be 36 by 18 by 12 inches. (After Biological Survey.)

struction. This trap is easy to make and the cost of the material is small. It has been tested on the agricultural grounds at Washington and also in the Missouri Botanical Gardens at St. Louis, and has caught hundreds of sparrows in a few weeks.

The following directions for making this trap are quoted from Farmer's Bulletin 493: —

The essential parts of this trap are: (1) a half funnel leading into (2) an antechamber, which ends in (3) a complete funnel leading into (4) a final chamber. It is made of woven wire poultry

netting of ¾-inch mesh, and is re-enforced around the open end and along the sides at the bottom by No. 8 or No. 10 wire, which is used also around the aperture for the door and around the door itself. The angles between the first funnel and the walls of the antechamber are floored with netting, and the final chamber is floored with the same material. The accompanying drawings will enable anybody handy with tools to construct one of these traps in a few hours. These plans are for a trap 3 feet long, a foot and a half wide, and a foot high. At ordinary retail prices the cost of material will be about 70 cents. Paper patterns for the two fun-

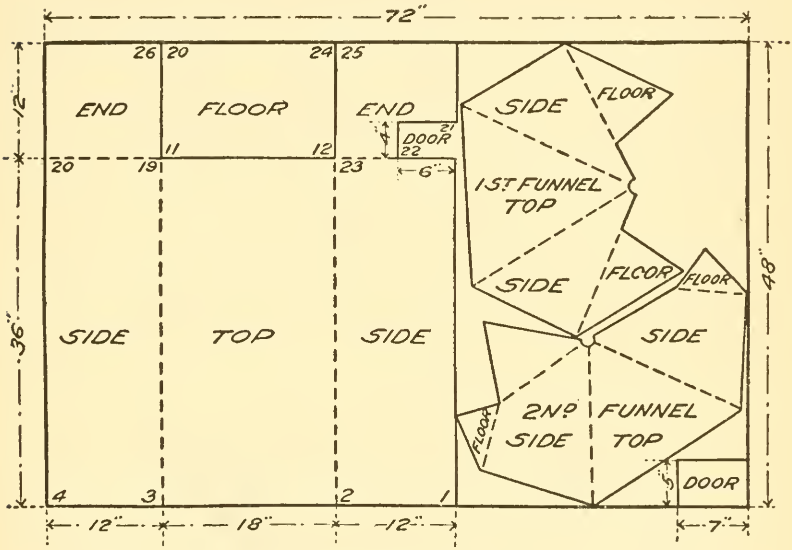


Fig. 7.—Diagram for cutting out the parts of a funnel trap 36 by 18 by 12 inches. (After Biological Survey.)

nels can be made by first drawing the concentric circles, as shown in Figs. 5 and 6, and then laying off the straight lines, beginning with the longest. The wavy outlines indicate that the pattern is to be cut half an inch outside of the straight lines to allow extra wire for fastening the cones to the top and sides of the trap. Fig. 7 shows how all the parts of a trap having the above dimensions may be cut from a piece of netting 4 feet wide and 6 feet long. The full lines in this figure indicate where the netting is to be cut and the broken lines where it is to be bent. The numbers at the angles in Figs. 5, 6 and 7 correspond with those in Fig. 4, which shows in outline the relation of the different parts as they appear when assembled. A trap of the above dimensions is as small as can be used satisfactorily. Where sparrows are very numerous a larger

size is recommended. Fig. 8 shows how a trap 4 feet long, 2 feet wide, and 15 inches high may be made from a piece of netting 4 by 10 feet. This is a very good size for parks and large private grounds.

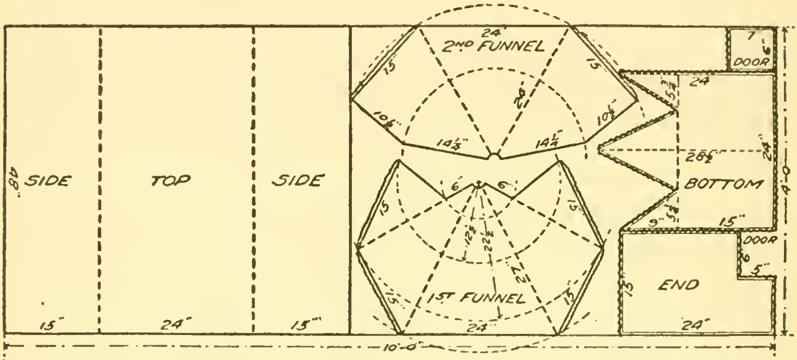


FIG. 8.—Diagram for cutting out the parts of a funnel trap 48 by 24 by 15 inches. (After Biological Survey.)

In setting a funnel trap a place should be selected where sparrows are accustomed to assemble. Often there are several such places in a neighborhood, in which case it is advisable to move the trap daily from one of them to another, because the birds appear to associate

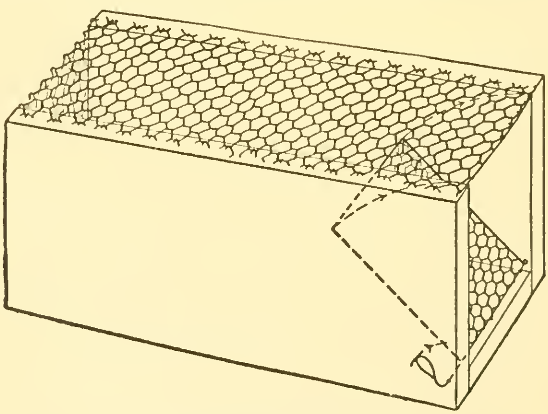


FIG. 9.—Receiving box for removing sparrows from trap. (After Biological Survey.)

the locality rather than the trap with the distress of their imprisoned comrades. Canary seed, hemp seed, wheat, oats, and bread crumbs are excellent baits. The bait should be scattered in the antechamber and first funnel and also, sparingly, outside about the entrance. A live sparrow kept in the trap as a decoy will facilitate

a catch. In case native birds enter a trap they may be released without harm. Trapping may begin at any time after young sparrows are able to take care of themselves, which is usually by July 1. Each day's catch should be removed from the trap at nightfall, and if a decoy is used it should be comfortably housed and otherwise cared for when off duty.

In removing sparrows from either a funnel or a sieve trap the receiving box shown in Fig. 9 will be found useful. It should be about 6 inches square and 18 inches long, inside measurement. The door, hinged at the bottom and turning inward, is controlled by the part of its wire frame extending through the side of the box to form a handle. The box as it appears in the figure is ready to be placed before the open door of a trap from which birds are to be driven.

Mr. Charles W. Miller, director of the Worthington Society for the Study of Bird Life, has perfected an excellent trap for sparrows which has been very successful, but as its construction is more complicated and its manufacture more expensive than that of the funnel trap, those who desire to try it are referred to Farmer's Bulletin 493, in which it is illustrated and described.

The Cedar Waxwing and the Elm-leaf Beetle.

One of the most beneficial of all orchard birds is the cedar waxwing, sometimes called the cherry bird. In the summer of 1911 I visited an apple orchard where the leaves were already somewhat riddled by cankerworms and swarms of these insects were seen everywhere on the trees. A large flock of cedar waxwings remained about this orchard for many days, and eventually destroyed nearly all the cankerworms so that the leaves and the fruit were saved. Among our native birds the cedar waxwing is probably the greatest foe of the elm-leaf beetle (*Galerucella luteola*). An item in one of the papers of western Massachusetts, published in the summer of 1911, stated that flocks of rare birds were feeding on elm-leaf beetles. Mr. J. M. Van Huyck of Lee informs me that the birds were cedar waxwings which are very likely to appear in numbers where destructive insects are at work on the trees, and which in some cases have absolutely cleared the trees of this pest. There is a great prejudice against this

bird because it eats many cherries, and many have been killed because of this habit, but probably the waxwing is much more beneficial than injurious.

Birds, Insects and Fruit.

Mr. J. Warren Jacobs of Waynesburg, Pa., sends me a photograph showing some samples of apples raised on his estate. He does not spray his trees, but puts up bird houses and attracts martins and other birds, with the result that he has a large number of martins in several large bird houses, and many other birds breeding about the place, and the birds protect his fruit from insect attacks.

Martins are great eaters of flying insects, and they destroy many pernicious pests. Mr. Jacobs tells in his "American Bird House Journal" of the remains of small beetles which were found in the nest rooms in his martin boxes after the young birds had taken flight. In 1911 he found similar beetles in the bark of a young apple tree. He sent some to Prof. H. A. Surface, State zoölogist of Pennsylvania, who replied that the insects were fruit tree bark beetles. These are deadly tree pests for which there is no good remedy. Mr. Jacobs says that in the midst of a triangle formed by the location of three martin houses on his place is a fine summer rambo apple tree planted in 1887. For twelve years this tree has borne heavily; the apples are large and delicious. The best apples were produced in 1909 when many single apples weighed 13 or 14 ounces. In 1911 many of the apples weighed 9 to 10 ounces each. One-half bushel of select specimens, numbering 41, weighed 21 pounds, averaging half a pound each. More than one-half of the apples taken from this tree were of this size and quality. Only a few yards from two of the martin houses were two "fall pippin trees." One is not a heavy bloomer, but in August, 1911, it had a good showing of fine large fruit untouched by insects. On August 28 the other tree was bending full of fine apples. Not far away were three plum trees: one of these, a peach plum, had borne so much fruit that all its branches drooped like a weeping willow. The other two trees were thickly set

Upper Figures. — Left: Flowerpots on the estate of Mr. Edward L. Parker, occupied by bluebirds and swallows. (Photograph taken by James G. Parker. See page 188.) Right: Successful bluebird box. (Photograph by R. L. Shewell. See page 188.)

Lower Figure. — Apples grown at Waynesburg, Pa., under the guardianship of a large colony of purple martins. The forty-one apples here shown weighed twenty-one pounds and filled a half-bushel measure heaping full. They are of the Western Beauty or Summer Rambo variety, and the tree was never sprayed. (Photograph by J. Warren Jacobs. See page 202.)

with fruit, nearly ready for gathering on August 28. There are many grapevines of different kinds bordering the garden walks. About these vines and trees 200 martins get much of their food, and many other birds are attracted by the insects about the place and by the bird houses that Mr. Jacobs puts up.

The winds from Winona Lake, at Winona, Ind., formerly carried many mosquitoes into the community near by. There were times when the pests were very annoying to crowds that gathered in the auditorium of the assembly to listen to Lyceum entertainments. Mr. Isaac W. Brown of Rochester, an ornithologist, made the suggestion that the assembly build homes for the purple martins, arguing that a large colony of these birds would soon reduce the mosquito pest. Mr. Albert E. Andrews states in "Our Dumb Animals" that hundreds of these birds are now at Winona Lake every summer, and that the mosquitoes have disappeared.

Bird Reservations or Sanctuaries.

A recent development in bird protection is the tendency to establish bird refuges, reservations, or sanctuaries, as they are called, where all useful birds may be protected.

The good results of the work done by Baron Von Berlepsch at his estate at Seebach, Thuringia, have attracted the attention of European governments, and in many cases his methods have been imitated. Mr. Henry Oldys states in "Current Items of Interest," No. 12, published by the Audubon Society of the District of Columbia, that in the government forests of the Grand Duchy of Hesse 9,300 nesting boxes have been placed for the birds, which are reported to utilize them each year. Old trees in the crown forests are left standing by governmental direction, in order that natural nesting places in hollow trunks and limbs may be retained. The federal States of Germany are providing in parks, woodlands and public reservations comforts and conveniences for the feathered tenants of the trees, pruning and cultivating trees and bushes to furnish attractive nesting places, and fashioning winter feeding houses.

Everywhere foresters are coming to recognize the value of birds. Nearly all species that inhabit the woods are believed to be beneficial to the trees. The city of Hamburg has a keeper of birds appointed by the State, and his services are at the disposal of private individuals who request his assistance.

Even in Great Britain, where bird protection has been brought to such perfection that birds are far more numerous than in America, the necessity of the bird sanctuary is recognized. In the Brent valley sanctuary birds are increasing each year, and Mr. Oldys tells us that the National Trust is endeavoring to raise £7,700 for the purchase of part of Colley Hill, on the Surrey Downs, to be used for a sanctuary for birds, flowers and insects. The necessity for such protection has been recognized in the British provinces. In New Zealand, where many rare birds are in danger of extinction, many bird sanctuaries have been established. Australia has an ornithologist's union and a Gould Society for the protection of birds similar to the Audubon Society in America.

In addition to the large number of bird refuges maintained by the United States government there are now many established by individual States, and private enterprise is aiding the movement. Mr. A. McIlhenny has started a heron preserve in Louisiana, and has developed a heronry there, the inhabitants of which now number many thousands, including snowy herons and American egrets. This experiment will be extended by the action of Messrs. Ward and McIlhenny in deeding to the State Game and Oyster Commission 13,000 acres of land to be perpetually maintained as a bird refuge. They have also established a refuge of 6,000 acres within 6 miles of the State reservation. Mr. Henry Ford of Detroit, Mich., has secured a large sanctuary for birds in Michigan where he has put up 1,500 shelter boxes for the birds, and a machine is now being made to manufacture nesting boxes similar to those used by Baron Von Berlepsch in Thuringia. Every effort is made to attract the birds, and many birds have taken advantage of the safety offered them on this

reservation. Song birds, game birds, squirrels and deer are protected there.

Mr. Ernest Harold Baynes, a well-known enthusiast in bird protection, has begun a work in Meriden, N. H., which has practically turned the whole village into a bird reservation. A permanent bird sanctuary has been established through the agency of the Meriden Bird Club, and many plants that furnish food for birds have been set out. The students of the Meriden Academy have been enrolled and they have joined with the people of the village in putting up bird houses, erecting food houses for the birds, feeding the birds and protecting them from their enemies, and have greatly increased the bird population in the village and the surrounding territory. Mr. Baynes has formed branch bird clubs not only in New Hampshire but also in other States in New England, where similar work is now being done.

A splendid example of co-operation for the protection of birds may be seen in Belmont, Mass. Three or four years ago large numbers of foreigners who were then at work in Belmont or the neighboring towns were very destructive to bird life, and at that time the members of the Field and Forest Club organized to resist the aggressions of these people. Mr. Samuel D. Robbins, secretary of the club, and also local secretary of the Massachusetts Audubon Society, has kindly written a report which follows: —

Report of the Committee on Bird Protection of the Forest and Field Club of Belmont, Mass., June, 1907, to 1912.

At a meeting of the Forest and Field Club of Belmont on June 6, 1907, a committee on bird protection was appointed to stop the wholesale slaughter of both song and game birds that was then going on in Belmont, and to protect the lives of those nature lovers who roamed through the Belmont woods.

The committee immediately obtained the written permission of the owners of two square miles of land to post their grounds with signs forbidding both shooting and trapping. Five hundred cloth signs were printed at once in both English and Italian. These read: "No shooting or trapping allowed within these grounds. The penalty for each violation of this order is a fine of not more than $20. Defacing these notices is prohibited by law, penalty not more than $25.

Five dollars reward will be paid for information to the chief warden of the Forest and Field Club of Belmont, which will lead to the arrest of any person violating these orders." In addition to these cloth signs, 2,000 paper signs containing the words "No shooting" in bold type were printed, and about 250 wooden signs reading, "No shooting," and bearing the name of the owner of the land, were painted. More than half of these signs have been posted in conspicuous places.

Thirteen public-spirited citizens volunteered to serve as game wardens without pay, and most of these were appointed special police officers of Belmont without pay by the selectmen. These wardens have held up more than 100 different gunners, and convicted 7 of these at court, 2 for trespass, 2 for hunting without a license, and 3 for hunting on Sunday. The wardens have seized a number of traps and exposed two wholesale snaring devices, securing the conviction of the man who was responsible for one of these.

As many gunners returned after being ordered off by the wardens, a card catalogue was started to keep track of such trespassers. Every warden was given a number of printed slips and instructed to fill one out in the presence of every gunner he met on the posted land or the public streets crossing it. On these slips the warden writes the trespasser's name, address, age, the number of the license if he carries one, the date, time and place of meeting, and any complaints he has to make, and warns the gunner he will take the card he has filled out to the office, where it will be filed in a card catalogue, and tells him he will be summoned to court if a second card with his name on it enters this file, whether it is dated five minutes later or five years later. Few gunners have returned since these cards were issued. The wardens are also supplied with whistles and a signal code by which they can help one another round up a gunner who is trying to make his escape. If a warden is assaulted, a short signal brings every warden on the force to his assistance immediately.

Realizing that prevention is often better than cure, the committee have tried, through the schools and public library, to educate the children to love the birds. The committee have had free lectures and bird talks for the school children in addition to those given by the club itself. They secured four cases of stuffed birds, containing 82 species, and purchased colored pictures of 167 species of the birds which are to be found in this vicinity for the children's room of the Belmont Public Library. On each of these pictures is written the dates the bird arrives in and leaves Belmont, whether it is a permanent resident, winter resident, winter visitant, or summer visitant; whether it is common or uncommon, or rare in this vicinity, and where it may be seen.

A different set of these pictures is hung up the first and third Monday of every month, except in the height of migration, when the sets are changed *every week*. The following groups are hung in the winter months: the permanent residents, birds with us the year round but not permanent residents, winter residents, winter visit-

12

FOREST & FIELD CLUB

Office, 727 Pleasant St. Phone, Belmont 245-3

Gunner's name

Gunner's address

street and number

Town , State

Age , Number of license

Date of issue of license

Date of trespass

Time spoken to in hours and minutes

Where spoken to

Charges 1.

2.

3.

Name of witness

Address of witness

Write remarks on the other side.

Facsimile of the slip issued by the Forest and Field Club to its members. As all legitimate gunners are registered under a license system in Massachusetts, and are required to have their license with them in the field, gunners may be readily identified. This makes the slip system effective.

ants, water fowl, shore birds and accidental visitors. During the spring migration every set contains a picture of every migrant and summer resident that is due from the south, and every winter bird that is due to leave for the north during the week; during the fall migration every set contains a picture of every migrant and winter bird that is due to arrive from the north, and every summer resident

that is expected to leave for the south during the week. Sets of various families of birds are hung during the summer months that the children may learn what birds belong to the finch family for example.

In addition to these library pictures the committee bought and gave to the Belmont public schools 426 similar pictures to be used as follows: every grammar school grade, from the third to the eighth, inclusive, was given a set of 21 or 22 pictures of common Belmont birds. These begin in the third grade with the most conspicuous and most abundant birds and gradually become less noticeable and less common in the higher grades. Beginning the 8th of September a picture is hung fortnightly in every grade for a period of two weeks until the 20th of April, when the pictures are changed every week until the close of school in June. Every bird honored by an Audubon Society educational leaflet has that leaflet with its picture. The local committee of the Massachusetts Audubon Society co-operated with this committee and gave a copy of Ralph Hoffman's "Guide to the Birds of New England and Eastern New York" to every floor of the four grammar school buildings. With these leaflets and books the teacher is expected to tell her class about the bird while its picture is on the wall, and encourage her pupils to find it in the field. These pictures are arranged in such an order that the child not only learns the easiest birds first, but has the picture before him at a time when the bird can be seen within a mile of the schoolhouse.

Extermination of Birds for the Market Demand.

The game, egg and feather markets are fast wiping out of existence the most useful and beautiful birds of the world. Mr. C. W. Beebe, who in the fall of 1911 returned from a long journey in Asiatic countries, informs us that many species of pheasants are nearing extinction. The wild game birds of all countries are being destroyed to supply the markets of the world. The number of birds killed for the millinery trade is beyond computation. Mr. James Buckland, of the British Museum, states that the British vice-consul at Ciudad Bolivar, Venezuela, says that the quantity of egret feathers exported in 1898 reached the high total of 2,839 kilos, and, considering that about 870 birds have to be killed to produce one kilo of the smaller feathers and about 215 for one kilo of the larger, the destruction of these birds must be very great. Were the number of birds killed equally divided between the two species, 1,538,738 birds must have been killed that year.

In the lake district of southern Oregon from 1900 to 1908 there were stationed during each season on the lakes from 20 to 30 camps of killers and skinners engaged in the slaughter of grebes. Wagons were driven to the camps regularly about three times each week to collect the skins. This continued until only a few scattered birds were left, when in 1908 the government set aside the Klamath lakes for bird reservations.

Some years ago, when the rage for humming birds was at its height, one London dealer received from the West Indies 400,000 skins in one year. This wholesale destruction has swept certain species out of existence and brought others near the vanishing point. Now the birds of paradise are being exterminated for the millinery trade. The beautiful long-plumed species, native to the Island of Jobi, formerly was numerous, but in 1906 only 70 skins were sent out from the island, although all the natives were hunting for them. The gorgeous red bird of paradise of the Island of Waigiou has become very rare and probably soon will be extinct. Some years previous to 1907 two Chinese traders in Humboldt Bay were exporting, every three months, about 12,000 bird skins, mainly those of the lesser bird of paradise. Every year every full-plumaged male of the great bird of paradise, which is found only in the Ayru Islands, is killed, and this species is being rapidly exterminated. The blue bird of paradise has become so scarce that 20 hunters were able to find only three specimens in a search of three weeks' duration over a large portion of its limited habitat. The crowned pigeon of New Guinea, the lyre bird and the regent bower-bird of Australia, the Indian roller of India and many other beautiful birds are now facing the same danger. Mr. Buckland states that more than 250,000 albatrosses have been killed in one year on a few islands in the Pacific Ocean. These birds, like most of the others, are killed in the breeding season, and the destruction of a pair of birds at that season means the destruction of their brood as well. Two hundred and fifty-nine thousand of these albatrosses were killed on Laysan Island, a United States government bird reservation, in 1910. The bird butchers were arrested by the crew of a United States revenue cutter, but too late to save the birds.

The albatrosses are killed by Japanese feather hunters, and the quills of the wings shipped to European milliners.

The millions of swallows and other migratory birds that are killed yearly in France, Italy and Spain supply the millinery trade of Europe with a tremendous quantity of wings and other plumage. Practically none of this now comes into the United States, where its sale is illegal. The greater part of the destruction of insect-eating birds of the United States for millinery purposes was stopped by the activity of the Audubon societies years ago, but it is stated that some small birds are still killed here and the skins shipped to Europe where they find a ready market.

While the laws of the northern States are so drawn as to protect insect-eating birds, such laws are not in force in several southern States. Vast numbers of small birds are killed for food in the south, and many of them are sold in the markets.

The National Association of Audubon societies has been enabled, through the philanthropy of Mrs. Russell Sage, to start an effective campaign of education in the schools of the south. Already the laws of some States have been improved as a result of this work, but a tremendous bird slaughter occurs annually in many States. A few years ago a single dealer in the national capital is said to have reported the sale of 2,600 robins in one month. These birds were killed in North Carolina. Robins, thrushes, flickers, native sparrows, bluebirds, orioles, tanagers, grosbeaks, blackbirds, bobolinks and even swallows have been and still are shot, sold and eaten in great numbers in the south. In the present winter (1911–12) the city council of Pittsboro, S. C., rescinded an order forbidding shooting within the city limits so that the people might shoot robins that had been driven into the town by a severe storm to seek food and shelter. About 4,000 robins were killed there. The mayor of the city, who was away at the time, was so disgusted at what had occurred that he resigned his office upon his return. A similar wholesale destruction of purple martins in another southern town was recorded in "Bird-Lore" a few years ago.

International Bird Protection.

One of the signs of the times which shows a public appreciation of the value of birds is an international movement for bird protection in which nearly all the principal nations of the world are represented. A conference of representatives from America and practically all European countries took place in Berlin in 1910. One good result of this conference was to bring out the fact that bird protection work had begun in Italy and other countries in which the people are very destructive to bird life. The movement for bird protection in those countries has much significance to us here, for immigrants from them are continually coming to our shores. Better laws and better sentiment for the protection of birds in European countries will tend in time to lessen the destruction of our birds here by these immigrants, and the work of the Audubon societies in the schools of America is designed to interest the children of immigrants in bird protection here. The international movement for bird protection eventually will help to stop the traffic in the plumage of birds, which is perhaps the most destructive factor to bird life to-day. The Australian and Indian governments have prohibited the exportation of the plumage, skins or eggs of native birds. Other countries already have passed such laws, but statutes forbidding the importation of foreign birds are now necessary. No matter how well we may protect the birds in this country they will be killed and smuggled out of the country for millinery purposes so long as they can be legally imported into other countries and sold there. And so long as our people are allowed to import and sell the feathers of foreign birds, these birds will be destroyed in countries where it is illegal to take them and their skins will be shipped here. Mr. James Buckland, who has been active in England and Germany in the attempt to establish laws prohibiting the importation of plumage, writes me on December 29 that he believes the German government will be the first European power to pass an act prohibiting the importation of plumage. It is hoped that England and America will follow.

The Result of prohibiting Spring Shooting.

The law prohibiting all shooting of wild fowl from January 1 to September 15, which the State Ornithologist has advocated for years and which was passed in 1909, has shown almost immediate results. Not only have large numbers of wild fowl remained along our coast during the entire winter for the last two seasons, but many have stayed through the summer. Many wood ducks and black ducks, and a few sheldrakes are now breeding in various parts of the State. Probably more wood ducks were seen in one locality last autumn in Massachusetts than have been seen in any New England State for several years. Where the rivers and ponds are open in winter black ducks and sheldrakes remain in considerable numbers. Reports of an increase in the number of wild fowl have come in from many parts of the State. And notwithstanding the fact that the autumns of the past few years have been very dry, and for this reason unfavorable for wild fowl in the interior of the State, large numbers of wild ducks have been seen and many more killed than usual. In many cases the records of years have been broken. In the fall of 1910 one man in Worcester County is said to have killed more ducks than any one has taken in that region within the memory of the oldest inhabitant, and great numbers of ducks and geese have been killed on the coast and on the island of Marthas Vineyard. The "Boston Globe" Nov. 22, 1911, stated that for the past two days there had been a great flight of wild geese, and that the shooting stands on the shore and at the ponds had bagged large numbers. When the law prohibiting spring shooting was passed, many of the gunners of Marthas Vineyard claimed that they would never have an opportunity to shoot another goose, but the "Globe" states that the gunners who have gone to Marthas Vineyard report the birds in large numbers, and that some of the sportsmen have had unusually good luck; also that the gunners on Marthas Vineyard and Nantucket have had excellent duck shooting. One man on Marthas Vineyard wrote me early in

the season that he had already killed 7 geese. Some people profess to believe that the increase of the birds is a mere coincidence, and that it will not be permanent; but a similar accession of birds has occurred in every State where similar laws have been passed and the change has been noted almost immediately. Most of the Canadian provinces stopped spring shooting in the last century. Michigan prohibited it in 1863, Wisconsin in 1874, Vermont in 1890, Ohio in 1900, California in 1901, Montana, New York and Idaho in 1903, Oregon and Utah in 1905, Connecticut in 1907 and Massachusetts in 1909; other northern States have in part stopped spring shooting, and wherever such laws have gone into effect there has been an increase in the wild fowl. Vermont was the first New England State to protect wild fowl throughout the late winter and spring months. Mr. W. T. Payne of Boston writes me that he and his friends have taken pains to enforce the law on the marshes where they shoot in Vermont in order that the ducks there may not be disturbed through the spring months, and as a result there has been no spring shooting of ducks in those marshes for years. He says that numbers of ducks and some geese have nested and reared their young there in 1911, that practically all kinds of ducks nest there, including mallard, black duck, widgeon, shoveller, blue-winged teal, green-winged teal, the gray duck (probably the pintail), the wood duck, bluebill and the golden-eye or whistler as well as Canada geese. I am informed also that sheldrakes nest in that region, and I have seen a photograph of a merganser on her nest, taken near there. Mr. Payne avers that the prohibition of spring shooting in Vermont, together with the careful enforcement of this law on these marshes during the spring and summer months, has accomplished wonders in the amount of ducks reared there, and that prior to the prohibition of spring shooting there were very few ducks in the marshes. Correspondents write me that in New York and New Jersey, in certain populous regions, numbers of wild ducks are now summering, and many are nesting since spring shooting was prohibited and

that even pintails and scaup or bluebills, which commonly nest in the far north, are now nesting in some of these marshes. There is no reason why we cannot rear large numbers of ducks and eventually geese also in Massachusetts if this law can be maintained and enforced.

Respectfully submitted,

EDWARD HOWE FORBUSH,
State Ornithologist.

SECOND ANNUAL REPORT

OF THE

State Inspector of Apiaries.

Presented to the Board and Accepted,
January 9, 1912.

SECOND ANNUAL REPORT OF THE STATE INSPECTOR OF APIARIES.

To the State Board of Agriculture.

I respectfully present the second annual report of the State Inspector of Apiaries for the year 1911.

The disease situation in Massachusetts has become more intimately known to the inspectors, and it is some gratification to find that the prophecies previously made have been found to be relatively correct. In a few instances the prevalence of disease was greater than had been anticipated.

The demands of the beekeepers continue to increase. Already, although it is midwinter, letters are coming in with inquiries and suggestions for early spring work.

The past season has been one of the most unfortunate in decades for beekeeping. This applies not only to Massachusetts but to the greater part of the United States. The extraordinary dearth of nectar in the field checked brood rearing to such an extent that disease treatment methods were not only handicapped but required the utmost skill and precaution. The success which has been met is, therefore, somewhat unexpected. Extreme heat and dryness during the summer, followed by extraordinary rains in the early fall, typify an adverse season for beekeeping and for inspection work. It is well recognized that treatment is easier and more satisfactory when there is a honey flow.

Nevertheless, the inspectors feel as a result of observations and general expression of beekeepers, that material benefit has been gained throughout the worst infected areas of the State, outlined in the last report. The areas formerly inspected have been revisited and greatly enlarged; others have been covered,—Berkshire County, southern Connecticut valley, Worcester County and a considerable part of Middlesex County, beside foci in other counties.

Although in the territory previously worked there was a most obvious improvement in the hygienic conditions of apiaries, and a noticeable decrease in the prevalence of disease, even to its entire eradication in particular instances, but stable conditions cannot be expected as yet. It is hoped that in the coming season, territories already covered will be so greatly improved, the beekeepers will be so much better informed and more confident, that the inspectors will be enabled to extend their efforts as was done this year.

While the following figures cannot be too strictly interpreted, they are suggestive of the large amount of work done. It was found that nearly one-third of the 3,717 colonies examined were infected, 309 with American foul brood and 575 with European foul brood, which may indicate that European foul brood is the more prevalent; at least, its extreme infectiousness and the rapidity with which it spreads are well recognized among apiarists. But the 745 apiaries visited, of which 234 were quarantined, do not at all represent the total number of calls made. In many instances it has been necessary to revisit infected apiaries repeatedly in order to give demonstrations and assistance, or reinspect for release from quarantine, — 133 releases having been granted, — and to insure proper precautions against the further spread of infection. A large number of calls also have been made where bees were said to have been kept, or where they were formerly maintained, but, as was frequently said, "all had died out from disease." The tracing of these discontinued apiaries is a most important feature of the service, its value being to prevent infection through carelessness, exposure of abandoned hives, combs, etc.; yet it is time-consuming. The total number of calls, therefore, should be estimated to exceed 1,500.

Due to the adverse summer and fall rains, in some apiaries the suppression of disease was not wholly accomplished before the end of the season. Also, it was not always possible to treat cases discovered late in August and September and especially in October. Thus 110 apiaries are still awaiting treatment in the spring, when the best results should be expected.

The relative ease with which disease has been suppressed when its presence was detected in June or early July has been

an agreeable surprise, at which beekeepers have frequently expressed their satisfaction. Thus, during the latter part of August it was possible to release from quarantine apiaries in which conditions had been exceedingly bad during the forepart of the season. The lack of success in those apiaries which were examined early has been traceable usually to a failure to carry out fully the instructions issued and precautions suggested by the inspectors.

Demonstrations.

Practicing that fundamental educational principle, outlined in the previous report, — the personal contact with the beekeeper, giving him insight into the modern methods and showing him "short cuts," as well as demonstrating methods of treatment, — has been thoroughly tested. The writer has in mind one instance of a demonstrational meeting of this sort at which every beekeeper in the town, excepting one who could not be reached, was present to observe the treatment of disease. Colonies were shaken and the apiary cleaned up. Those beekeepers present, including one from New Hampshire, of course went back to their homes and communicated to their beekeeping acquaintances what they had learned. In some instances, however, the demonstrations have been attended by only one or two. As an index to how extensively this instruction has been practiced, it may be said that in Worcester and Middlesex counties 191 demonstrations were held in 1911. What happened there holds throughout the State, the writer having demonstrated in a mill town in Berkshire County as late as half-past seven to 8 o'clock in the evening, in order that the mill operatives who were beekeepers might attend.

The Process of Inspection.

Methods as outlined previously have been tried and proved. The greatest benefits can best be obtained by a systematic and concentrated effort; thus considerable areas have been thoroughly covered by a canvass from apiary to apiary. Scattering inspection, as has been tried in other States, can hardly be as satisfactory. When the State has been covered, its status, in relation to other States, will be fixed. The aim now is to complete the survey as soon as possible.

Miscellaneous Work.

Correspondence. — The service through correspondence has materially increased. Inquiries have not been confined to Massachusetts nor to New England, but have come from all parts of the United States, Canada, and the island possessions. This feature of the work proves to be a considerable tax upon the time and resources of the service. An attempt is being made to better the facilities.

Records. — Efficiency has been materially increased by the use of a card system of records, whereby it is possible at any time to gain at a moment's glance a relatively comprehensive idea of the work done in different parts of the State. The system also insures accuracy, uniformity and simplicity in the field work.

Publications. — Two bulletins of the "apiary inspection" series have been issued.[1]

The large edition of the first publication, "Brood Diseases of Bees, their Treatment, and the Law for their Suppression in Massachusetts", is out of print. Constant inquiries for this paper indicate the necessity for publishing a revised edition.

Appointments. — The appointments of deputies are as follows: John L. Byard, Marlborough; Irving W. Davis, Lowell; and William H. Thatcher, North Adams.

Attendance at Meetings. — Besides having lectured before granges and other societies upon bee problems, especially those connected with disease, the inspector or deputies have attended the important meetings and field days throughout the State, as well as the convention of the National Beekeepers' Association at Minneapolis, and the meeting of the Cape Cod Cranberry Growers' Association, at which two latter meetings problems in relation to bee diseases were discussed. At the national convention it was significant to observe the interest which delegates had in the method and progress of apiculture in Massachusetts.

Convention of Inspectors of Apiaries in Northeastern United States.

Formerly apiary inspection had little organization or system. In some States it had been optional with the beekeeper; in others, fluctuating, local or voluntary without the authority of

[1] Bulletin No. 2, Annual Report of the State Inspector of Apiaries for the year 1910. Bulletin No. 3, Warning to Beekeepers and Users of Bees in Greenhouses.

law. The last two or three years, however, have seen radical changes. It is now not only recognized as meritorious, but of vital and fundamental importance in the promotion of agriculture and particularly horticulture. The grade of inspection is being improved, and the number of States having this service has recently greatly increased. Now every State in New England has apiary regulations excepting New Hampshire and Maine.

Inspectors' methods are becoming more precise, thorough and uniform. With such progress certain problems, common to the several States, have arisen. For illustration, there is the question of interstate shipment of diseased stock, which interests other States more particularly than Massachusetts; the general hygiene of the apiary; quarantine stations, being suggested for Canada; the disposal of stray swarms in trees and on public lands. Such problems, when settled, should mean better service. It is proposed to call a meeting of those engaged in inspection service in northeastern United States at which these important topics will be considered. The project is meeting with decided interest in States as far away as Pennsylvania. Greater co-operation, uniformity and efficiency are anticipated as a result of this meeting.

By the discovery of disease along the Massachusetts border of New Hampshire, and according to reports from that State, it would seem desirable to further any advance toward inspection in Maine and New Hampshire which may be made. It is hoped that representatives from these States will be in attendance at the convention of inspectors.

Financial Statement, Nov. 30, 1911.

Unexpended balance, appropriation of 1910,		$99 96
Appropriation, 1911,		1,400 00
From extraordinary expenses,		692 94
Services of inspectors,	$1,190 00	
Travel and necessary expenses of inspectors,	629 39	
Postage,	97 17	
Printing and stationery,	168 37	
Stenographic and clerical assistance,	48 36	
Telephone and sundries,	8 62	
Unexpended balance,	50 99	
	$2,192 90	$2,192 90

During their first season's service the deputies have repeatedly encountered trying and perplexing problems which, the inspector is glad to acknowledge, have been earnestly and conscientiously handled. The continuance of the interest of the State Board of Agriculture is appreciated, also, not only by those in the inspection service, but by the beekeepers as well.

Respectfully submitted,

BURTON N. GATES,

State Inspector of Apiaries.

JAN. 9, 1912.

TWENTY-FIRST ANNUAL REPORT

OF THE

DAIRY BUREAU

OF THE

MASSACHUSETTS
STATE BOARD OF AGRICULTURE

REQUIRED UNDER

CHAPTER 89, SECTION 12, REVISED LAWS.

PRESENTED TO THE BOARD AND ACCEPTED,
JANUARY 9, 1912.

DAIRY BUREAU — 1911.

CHARLES M. GARDNER, WESTFIELD, *Chairman.*
HOWARD A. PARSONS, NORTH AMHERST.
GEORGE W. TRULL, TEWKSBURY, P. O. LOWELL, R. F. D.

Secretary.

J. LEWIS ELLSWORTH, *Executive Officer and Secretary of the State Board of Agriculture.*

General Agent.

P. M. HARWOOD.

ADDRESS, ROOM 136, STATE HOUSE, BOSTON.

REPORT OF THE DAIRY BUREAU.

There have been entered in court, during the year 1911, 219 cases, 157 of which were for violation of the oleomargarine laws, 60 for violation of the renovated butter law and 2 for violation of the milk adulteration law, resulting in 215 convictions, 1 case nol-prossed, and 3 discharged. Seven thousand two hundred and eighty-one inspections of stores, wagons, etc., have been made by the agents; most of the creameries, milk depots,[1] etc., have been inspected by members of the Bureau, and suggestions made as to bettering conditions where needed.

By way of educational work special dairy meetings have been held at Barre, Littleton, Newbury, New Bedford, Shelburne, Worcester and Wayland. These meetings have been addressed by leading dairy experts from various parts of the country. Other meetings have been addressed by the general agent, making a total of 26 lectures.

Milk Supply.

It is worthy of comment that United States government officials and others agree that the milk supply of this State is among the best in the country. To those who have closely watched the improvement which has been going on for years this seems but the logical result of constant and persistent effort. May the improvement continue, and Massachusetts never be elsewhere than in the front of the procession in the matter of her milk supply.

In our annual reports since 1906 we have from time to time called attention to the decline in volume of dairying in

[1] We especially commend the methods and care exercised by the Willow Brook Dairy Company at Sheffield, Mass. This plant is new and with its modern appliances and system of buying comes the nearest to an ideal of any shipping station we have seen.

this State, as shown by the decreasing number of cows year by year. We are glad to note that, according to the last assessors' returns, the decline has ceased, and the business seems at present to be holding its own.

Pasteurized Milk.

Most of the market milk sold in Boston is pasteurized. Many physicians and sanitarians advocate this as a precaution against disease. The great objection to pasteurization is that it provides an opportunity to sell old milk that otherwise might be unsalable. Clean milk pasteurized is a safe and desirable product, and there should be regulations by local authorities requiring in some way a guarantee in relation to its age, and also its bacteria count at the time of pasteurizing.

Condensed Milk.

The act recommended last year by the Bureau, requiring a formula for the dilution of reduced milks with water, to make standard fluid milk equivalent, became a law Jan. 1, 1912. It is reported that twenty carloads of condensed and evaporated milk are brought into this State each month, and more than 17,000 retail dealers are selling these goods. The evaporated milk output in the United States increased 154 per cent, and the condensed milk output 6 per cent, during the five years 1905–10. If evaporated and condensed milks are used to such a large degree it seems desirable that the age be known, and we recommend the following amendment to section 59, chapter 56, of the Revised Laws, with a view to accomplishing this result: —

An Act relative to the Sale of Condensed, Concentrated or Evaporated Milk or Skimmed Milk.

Be it enacted, etc., as follows:

Section 1. Section fifty-nine of chapter fifty-six of the Revised Laws is hereby amended by inserting before the word "milk", where it first occurs in line two, the words: — condensed or evaporated, — by striking out the word "condensed", in line two, — by striking out the word "and", in line four, — by inserting after

the word "can", in line five, the words: — and date of manufacture, — by inserting after the word "condensed", in line five, — the words: — concentrated or evaporated, — by inserting after the word "milk", in line five, the words: — or skimmed milk, — by inserting after the word "manufacture", in line seven, the words, — and date of manufacture, — so as to read as follows: — *Section 59.* Whoever sells, or offers for sale or exchange, condensed, concentrated or evaporated milk or skimmed milk in hermetically sealed cans without having such cans distinctly labeled with the name of the manufacturer of such milk, the brand under which it is made, the contents of the can and the date of manufacture; and whoever sells condensed, concentrated or evaporated milk or skimmed milk from cans or packages not hermetically sealed, without having such cans or packages branded or labeled with the name of the manufacturer, and date of manufacture, shall be punished as provided in section fifty-five.

SECTION 2. This act shall take effect upon the first day of September, nineteen hundred and twelve.

Milk Consumption.

Consumption of unreduced fluid milk, in Boston at least, shows a marked decline in the last five years. In 1906, 114,-233,976 quarts were shipped in by rail, while in 1910, 100,-606,362½ quarts were shipped by rail, showing a decline in four years of 13,627,573½ quarts. During the twelve months, Dec. 1, 1910, to Nov. 30, 1911, there was a further decline of 10,513,590½ quarts, making a total decrease of 24,141,204½ quarts in five years.

This Bureau is, and always has been, in favor of clean milk, and we believe that two essentials are necessary in procuring it. One is the inspection of the milk daily, as it leaves the farmer's hands, for bacteria count, requiring that it be below a fixed standard, and the other is that the farmer be paid for so producing and delivering it. This milk should again be inspected by the local authorities in the various cities and towns at the point of delivery. Such inspection would accomplish results, but would increase the cost, and therefore might raise the present price of market milk. It is for the public to decide, by its willingness to pay, whether or not such milk is wanted.

Oleomargarine.

The number of retail oleomargarine licenses in force in this State November, 1910, was 698, while in 1911 it was 459, showing a decrease of 239. Oleomargarine receipts in Boston, as reported by the Chamber of Commerce in 1910, were 138,981 packages, while in 1911 it was 104,685, showing a decrease of 34,296 packages. Oleomargarine produced in the United States in 1910 was 141,862,280 pounds, while in 1911 it was 121,279,001 pounds, showing a decrease of 20,593,279 pounds.

Renovated Butter.

In 1910 there were 47,433,574 pounds of renovated butter produced in the United States, while in 1911 there were 39,292,591 pounds, showing a decrease of 8,140,984 pounds in twelve months.

Butter.

The average wholesale price of butter, per Chamber of Commerce reports, for 1910 was 30.2 cents, while in 1911 it was 27.3 cents. The increased consumption of butter in 1911 over 1910, Boston output, was 4,294,156 pounds, which, when compared with the figures given under the two preceding heads, shows how intimately connected are these three products, and how dependent all are upon the price of butter.

Massachusetts Dairymen's Association.

For some years this Bureau has advocated the organization of a State Dairymen's Association. We are glad to report that such an association is now an accomplished fact, the Massachusetts Dairymen's Association having been chartered during the summer of 1911. We believe there are great possibilities for this organization.

Personnel of the Bureau.

The personnel of the Bureau has remained unchanged and is as follows: Charles M. Gardner of Westfield, chairman, Howard A. Parsons of Amherst and George W. Trull

of Tewksbury. The executive force, agents, chemists, etc., are as follows: executive officer and secretary, J. Lewis Ellsworth; general agent, P. M. Harwood; B. F. Davenport, M.D., of Boston, and F. W. Farrell of the Emerson Laboratory, Springfield, have done the chemical work. A. W. Lombard has continued to act as agent, and five others have been temporarily employed from time to time.

Summary of Police Work.

Total number of inspections, ...	[1] 7,281
Number of inspections where no sample was taken, . .	5,995
Number of samples of butter and oleomargarine, all purchased, ...	1,282
Number of samples of milk and cream, ...	35
Cases entered in court, ...	219
Addresses by general agent and others, ...	26

Cases prosecuted during the twelve months ending Nov. 30, 1911, by months and courts, with law violated, and results, are as follows: —

Court.	Month.	Number.	Law violated.	Convicted.	Discharged.
Newburyport, Police, .	December, .	6	3 oleomargarine, 3 renovated butter.	6	-
Worcester, Central District,	December, .	2	1 oleomargarine, 1 renovated butter.	2	-
Springfield, Police, . .	December, .	13	Oleomargarine, .	13	-
Salem, First Essex District,	December, .	2	Oleomargarine, .	2	-
Holyoke, Police, . . .	January, .	12	6 oleomargarine, 6 renovated butter.	12	-
Springfield, Police, . .	January, .	28	18 oleomargarine, 10 renovated butter.	28	-
Attleborough, Fourth Bristol District.	January, .	4	Renovated butter,	4	-
Waltham, Police, . .	January, .	8	Oleomargarine, .	8	-
Chicopee, Police, . .	January, .	2	Oleomargarine, .	1 [2]	1
New Bedford, Third Bristol District.	January, .	23	Oleomargarine, .	23	-
Newton, Police, . . .	January, .	2	Oleomargarine, .	2	-
Malden, First Eastern Middlesex.	February, .	1	Oleomargarine, .	1	-
Attleborough, Fourth Bristol District.	February, .	11	4 oleomargarine, 7 renovated butter.	11	-
Lowell, Police, . . .	February, .	10	8 oleomargarine, 2 renovated butter.	10	-
Fitchburg, Police, . .	March, .	4	Oleomargarine, .	4	-

[1] There were 31 extra samples taken during the year, therefore this number is less than the sum of the next three items.

[2] Convicted in lower court but nol-prossed by district attorney in Superior Court.

Court.	Month.	Number.	Law violated.	Convicted.	Discharged.
Webster, First Southern Worcester.	March,	17	2 oleomargarine, 15 renovated butter.	17	–
Leominster, Police,	March,	1	Oleomargarine,	1	–
Greenfield, Franklin District.	March,	2	Oleomargarine,	2	–
Springfield, Police,	March,	3	Oleomargarine,	3	–
Spencer, Western Worcester,	March,	8	2 oleomargarine, 6 renovated butter.	8	–
Lynn, Police,	March,	5	Oleomargarine,	4	1
Dedham, Northern Norfolk,	April,	2	Renovated butter,	2	–
Worcester, Central District,	April,	9	Oleomargarine,	9	–
Ayer, First Northern Middlesex,	March,	1	Milk,	–	1
Uxbridge, Second Southern Worcester.	May,	1	Oleomargarine,	1	–
Boston, Municipal,	June,	1	Oleomargarine,	1	–
Fall River, Second Bristol,	May,	2	Oleomargarine,	2	–
Springfield, Police,	July,	1	Milk,	1	–
Worcester, Central District,	July,	1	Oleomargarine,	1	–
Boston. Roxbury District,	August,	2	Renovated butter,	2	–
Plymouth, Third Plymouth,	October,	2	Oleomargarine,	2	–
Abington, Second Plymouth,	October,	4	Oleomargarine,	4	–
Chelsea, Police,	November,	3	Oleomargarine,	3	–
Quincy, Eastern Norfolk,	November,	26	24 Oleomargarine, 2 renovated butter.	26	–

Note. — The Bureau is especially indebted to the milk inspectors of Boston, Chelsea, Revere, Salem, Springfield and Worcester for assistance which has resulted in cases in court. We also record our indebtedness to all others who have aided us in any way.

The charges in the several cases entered in court for the year ending Nov. 30, 1911, have been as follows: —

Selling renovated butter in unmarked packages,	60
Selling oleomargarine when butter was asked for,	9
Selling oleomargarine without being registered,	4
Selling oleomargarine without sign on exposed contents,	2
Selling oleomargarine in unmarked[1] packages,	32
Selling oleomargarine from unmarked wagons,	4
Furnishing oleomargarine in restaurants, etc., without notice, to guests,	106
Selling milk containing added water,	2
	219

[1] In these cases oleomargarine was sold when butter was asked for, but the charge was made in this way for convenience.

The following is a list of inspections without samples and the number of samples taken in the years 1903–11, inclusive: —

Year.	Inspections without Samples.	Samples taken.
1903,	4,135	1,395
1904,	4,456	1,157
1905,	4,887	971
1906,	4,985	576
1907,	4,538	1,374
1908,	5,516	1,575
1909,	5,003	1,869
1910,	6,121	1,960
1911,	5,995	1,282
Totals,	45,636	12,159
Averages,	5,070+	1,351

Oleomargarine.

No sales of colored oleomargarine have been discovered by the agents of the Bureau during the year.

On account of the lower price of butter the oleomargarine trade has declined somewhat. Some idea of the extent of this may be obtained from a comparison of uncolored oleomargarine licenses in force in Massachusetts in November, 1910 and 1911, with the prices of butter for those years.

	1910.	1911.
Wholesale licenses in Boston,	21	20
Wholesale licenses in other cities,	9	8
Total,	30	28
Retail licenses in Boston,	91	61
Retail licenses in other cities and towns,	607	398
Total,	698	459

For prices of butter see page 235.

The following figures, taken from the annual report of the United States Commissioner of Internal Revenue for

1911, show the production, withdrawn tax paid, and withdrawn for export of the two classes of oleomargarine, as defined by act of May 9, 1902, covering the period of nine years, since it went into effect on July 1, 1902: —

Oleomargarine (Pounds).

Year.	Product taxed at Rate of 10 Cents per Pound.[1]			Product taxed at Rate of ¼ Cent per Pound.[2]		
	Produced.	Withdrawn Tax paid.	Withdrawn for Export.	Produced.	Withdrawn Tax paid.	Withdrawn for Export.
1903,	5,710,407	2,312,493	3,334,969	67,573,689	66,785,796	151,693
1904,	3,785,670	1,297,068	2,504,940	46,413,972	46,397,984	123,425
1905,	5,560,304	3,121,640	2,405,763	46,427,032	46,223,691	137,670
1906,	4,888,986	2,503,095	2,422,320	50,545,914	50,536,466	78,750
1907,	7,758,529	5,009,094	2,695,276	63,608,246	63,303,016	129,350
1908,	7,452,800	4,982,029	2,522,188	74,072,800	73,916,869	109,480
1909,	5,710,301	3,275,968	2,403,742	86,572,514	86,221,310	112,958
1910,	6,176,991	3,416,286	2,767,195	135,685,289	135,159,429	97,575
1911,	5,830,995	2,764,971	3,054,344	115,331,800	115,448,006	91,770
Total,	52,874,983	28,682,644	24,110,737	686,231,256	683,992,567	1,032,651

[1] Colored oleomargarine. [2] Uncolored oleomargarine.

In Boston the Chamber of Commerce reports receipts for 1911, 104,685 packages, against 138,981 in 1910, — a decrease of 34,296 packages.

Renovated Butter.

Violations of the renovated butter law in this State during the year have been less than in 1910. The lower price of butter has caused less of the goods to be used than was the case last year. There is one licensed concern in this State manufacturing renovated butter.

The following figures, from the same source as the preceding table, show the production and withdrawn tax paid of renovated butter, 1902–11: —

Renovated Butter (Pounds).

Year.	Production.	Withdrawn Tax paid.
1903,	54,658,790	54,223,234
1904,	54,171,183	54,204,478
1905,	60,029,421	60,171,504
1906,	53,549,900	53,361,088
1907,	62,965,613	63,078,504
1908,	50,479,489	50,411,446
1909,	47,345,361	47,402,382
1910,	47,433,575	47,378,446
1911,	39,292,591	39,352,445
Total,	469,925,923	469,583,527

Butter.

The annual statement of the Chamber of Commerce, as will be seen by the appended tables, shows increase in the consumption of butter during 1911, due undoubtedly to the lower wholesale average price of 27.3 cents per pound, the lowest since 1906.

The following table shows the average quotation for the best fresh creamery butter, in a strictly wholesale way, in the Boston market for the last ten years, as compiled by the Boston Chamber of Commerce: —

Month.	1911. Cents.	1910. Cents.	1909. Cents.	1908. Cents.	1907. Cents.	1906. Cents.	1905. Cents.	1904. Cents.	1903. Cents.	1902. Cents.
January,	28.8	33.5	30.9	29.7	30.4	25.2	28.0	22.7	28.0	25.0
February,	26.9	30.5	30.0	32.1	31.7	25.2	31.6	24.6	27.0	28.5
March,	24.2	32.0	29.1	30.2	30.2	25.5	28.0	24.1	27.0	29.0
April,	21.7	31.5	27.9	28.4	32.2	22.2	29.1	21.6	27.5	32.0
May,	22.8	29.0	26.6	24.1	31.4	19.9	23.9	19.9	22.5	25.0
June,	24.2	28.2	26.4	24.5	24.3	20.2	20.7	18.4	22.75	23.5
July,	26.0	28.6	27.2	23.6	25.9	21.0	20.6	18.3	20.5	22.5
August,	27.2	29.6	28.2	24.5	26.0	23.8	21.6	19.1	20.0	21.5
September,	27.7	29.6	31.3	25.3	29.2	25.6	21.2	20.8	22.0	23.5
October,	30.4	29.4	31.7	27.5	29.9	26.9	22.1	21.5	22.5	24.5
November,	32.5	30.2	31.4	29.5	27.1	27.6	23.0	24.1	23.5	27.0
December,	35.0	30.0	32.9	31.0	27.5	30.7	23.9	25.7	24.5	28.5
Average,	27.3	30.2	29.5	27.5	28.48	24.48	24.47	21.73	26.23	25.0

The Chamber of Commerce figures regarding the butter business in Boston for 1910 and 1911 are as follows: —

	1911. Pounds.	1910. Pounds.
Carried over,	12,272,624	8,030,740
Receipts for January,	2,058,615	2,763,388
Receipts for February,	2,834,187	2,735,471
Receipts for March,	3,290,750	3,202,183
Receipts for April,	3,741,069	2,617,479
Receipts for May,	6,070,694	7,953,512
Receipts for June,	12,254,528	13,291,088
Receipts for July,	8,282,769	10,529,244
Receipts for August,	7,702,794	8,371,256
Receipts for September,	6,288,939	7,455,963
Receipts for October,	5,000,839	5,499,123
Receipts for November,	3,329,460	2,904,893
Receipts for December,	3,019,606	2,094,240
Total supply,	76,146,874	77,451,580
Exports for year, deduct,	74,448	13,650
Net supply,	76,072,428	77,437,930
Storage stock December 30, deduct,	6,612,966	12,272,624
Consumption for year,	69,459,462	65,165,306
Gain, 4,294,156 pounds.		

MILK.

Milk brought into Boston by Different Railroads, Dec. 1, 1910, to Nov. 30, 1911, as reported by the Railroad Commissioners (Quarts).

DATE.	Boston & Albany.	Boston & Maine.	New York, New Haven & Hartford.	Total.
1910.				
December,	837,902	3,893,803	1,891,326	6,623,031
1911.				
January,	954,991	3,920,531	1,943,600	6,819,122
February,	778,233	3,810,408	1,798,264	6,386,905
March,	947,997	3,874,625	2,005,974	6,828,596
April,	970,421	4,162,647½	1,819,823	6,952,891½
May,	1,000,904	4,581,592	2,007,567	7,590,063
June,	1,059,773	4,742,761½	2,023,276	7,825,810½
July,	814,939	6,206,046	1,702,749	8,723,734
August,	807,635	5,135,598	1,918,993	7,862,226
September,	794,337	5,285,888	1,910,729	7,990,954
October,	904,345	5,492,557	1,795,274	8,192,176
November,	1,042,719	5,675,805	1,578,739	8,297,263
Total,	10,914,196	56,782,262	22,396,314	90,092,772

Milk brought into Boston by Railroad for Twelve Months ending November 30 of Each Year (Quarts).

1906,	114,233,976
1907,	109,882,190½
1908,	103,381,278½
1909,	108,082,936
1910,	100,606,362½
1911,	90,092,772
Total decrease in five years,	24,141,204
Average annual decrease,	4,828,241

Number of Cows assessed in Massachusetts.

May 1, 1906,	181,816
April 1, 1910,	166,048
April 1, 1911,	166,500
Total decrease in five years,	15,316
Average annual decrease,	3,063

Local Milk Inspectors.

Milk Inspectors for Massachusetts Cities, 1911.

Beverly,	Henry E. Dodge, 2d.
Boston,	Prof. James O. Jordan.
Brockton,	George E. Bolling.
Cambridge,	Dr. Ernest H. Sparrow.
Chelsea,	Arthur H. Upton.
Chicopee,	C. J. O'Brien.
Everett,	E. Clarence Colby.
Fall River,	Henry Boisseau.
Fitchburg,	John F. Bresnahan.
Gloucester,	Dr. George E. Watson.
Haverhill,	Homer L. Connor, M.D.
Holyoke,	Daniel P. Hartnett.
Lawrence,	Eugene A. McCarthy.
Lowell,	Melvin F. Master.
Lynn,	Alexander S. Wright.
Malden,	J. A. Sandford.
Marlborough,	John J. Cassidy.
Medford,	Winslow Joyce.
Melrose,	Caleb W. Clark, M.D.
New Bedford,	Herbert B. Hamilton, D.V.S.
Newburyport,	Dr. R. D. Hamilton.

Newton,	Arthur Hudson.
North Adams,	Henry A. Tower.
Northampton,	George R. Turner.
Pittsfield,	Eugene L. Hannon.
Quincy,	Edward J. Murphy.
Salem,	John J. McGrath.
Somerville,	Herbert E. Bowman.
Springfield,	Stephen C. Downs.
Taunton,	Lewis I. Tucker.
Waltham,	Arthur E. Stone, M.D.
Woburn,	Edward P. Kelly, M.D.
Worcester,	Gustaf L. Berg.

Milk Inspectors for Massachusetts Towns, 1911.

Adams.	Dr. A. G. Potter.
Amesbury.	E. S. Worthen.
Andover.	Franklin H. Stacey.
Arlington.	Dr. L. L. Pierce.
Attleborough,	Caleb E. Parmenter.
Barnstable,	George T. Mecarta.
Belmont,	Prof. Samuel C. Prescott.
Brookline,	Frederick H. Osgood.
Clinton,	Gilman L. Chase.
Concord,	Erastus H. Smith.
Easthampton,	George L. McEvoy.
Gardner,	Clifford W. Shippee.
Greenfield,	George P. Moore.
Hudson,	Dr. A. L. Crandall.
Hyde Park,	James G. Bolles.
Leominster,	William H. Hodge, D.V.S.
Ludlow,	A. L. Bennett, D.V.S.
Millbury,	Arthur A. Brown.
Monson,	E. W. Capen.
North Attleborough,	Hugh Gaw, V.S.
Palmer,	Edward P. Brown.
Peabody,	H. S. Pomery, M.D.
Revere,	Joseph E. Lamb.
Salisbury,	John H. Pike.
South Framingham,	Dr. J. H. McCann.
South Hadley Falls,	George F. Boudreau.
Spencer,	James A. Spencer.
Stoneham,	George H. Allen.
Wakefield,	Harry A. Simonds.

Ware, ...	Fred E. Marsh.
Watertown, ...	Luther W. Simonds.
Wellesley, ...	Cecil K. Blanchard.
Westfield, ...	William H. Porter.
West Springfield, ...	Norman T. Smith.
Williamstown, ...	G. S. Jordan, V.S.
Winchendon, ...	Frederick W. Russell, M.D.
Winchester, ...	Morris Dineen.

Creameries, Milk Depots, etc.

Co-operative Creameries.

Number and Location.	Name.	Superintendent or Manager.
1. Ashfield, . . .	Ashfield Creamery, . . .	William Hunter, manager.
2. Belchertown, . .	Belchertown Creamery, . .	M. G. Ward, president.
3. Cummington, . .	Cummington Creamery, . .	D. C. Morey, superintendent.
4. Easthampton, . .	Hampton Creamery, . .	W. H. Wright, treasurer.
5. Egremont (P. O. Great Barrington).	Egremont Creamery, . .	E. Q. Tyrrell, manager.
6. Monterey, . . .	Berkshire Hills Creamery, .	F. A. Campbell, treasurer.
7. New Salem (P. O. Millington).	New Salem Creamery, . .	W. A. Moore, treasurer.
8. Northfield, . . .	Northfield Co-operative Creamery Association.	Charles C. Stearns, superintendent.
9. Shelburne, . . .	Shelburne Creamery, . .	Ira Barnard, manager.
10. Westfield (P. O. Wyben),	Wyben Springs Creamery, .	C. H. Kelso, manager.
11. West Newbury, . .	West Newbury Creamery, .	R. S. Brown, treasurer.

Proprietary Creameries.

Number and Location.	Name.	Owner or Manager.
1. Amherst, . . .	Amherst Creamery Company, .	R. W. Pease, manager.
2. Amherst, . . .	Fort River Creamery, . .	E. A. King, proprietor.
3. Brimfield, . . .	Crystal Brook Creamery, . .	F. N. Lawrence, proprietor.
4. Everett, . . .	Hampden Creamery Company,	Hampden Creamery Company.
5. Fitchburg, 26 Cushing Street.	Fitchburg Creamery, . .	G. S. Learned, proprietor.
6. Gardner, . . .	Boston Dairy Company, . .	Boston Dairy Company.
7. Groton, . . .	Lawrence Creamery, . .	Myron P. Swallow, manager.
8. Heath, ...	Cold Spring Creamery, . .	I. W. Stetson & Son.
9. Hinsdale, . . .	Hinsdale Creamery, . . .	Walter C. Solomon, proprietor.
10. Marlborough, . .	Este's Creamery, . . .	F. F. Este, proprietor.
11. North Brookfield, .	North Brookfield Creamery, .	H. A. Richardson, proprietor.

Educational.

Number and Location.	Name.	Owner or Manager.
Amherst, ...	Dairy Industry Course, Massachusetts Agricultural College.	W. P. B. Lockwood, professor in charge.

Milk-distributing Depots.

Name.	Location.	Manager.
Alden Brothers Company, Oak Grove Farm.	Boston office, 1171 Tremont Street, Depot, 24-28 Duncan Street.	Charles L. Alden, president, John Alden, treasurer.
Boston Dairy Company, .	Boston, 484 Rutherford Avenue, .	W. A. Graustein.
C. Brigham Company, .	Cambridge, 158 Massachusetts Avenue.	John K. Whiting.
C. Brigham Company, .	Worcester, 9 Howard Street, . .	C. Brigham Company.
Deerfoot Farms, . .	Southborough, ...	S. H. Howes.
Elm Farm Milk Company,	Boston, Wales Place, . . .	James H. Knapp, treasurer.
H. P. Hood & Sons, . .	Boston, 494 Rutherford Avenue; branch, 24 Anson Street, Forest Hills.	Charles H. Hood.
	Lynn, 193 Alley Street.	
	Malden, 425 Main Street.	
	Salem, 252 Bridge Street.	
	Watertown, 289 Pleasant Street.	
	Lawrence, 629 Common Street.	
Springfield Creamery, .	Springfield, ...	F. B. Allen, proprietor.
Tait Brothers, . . .	Springfield, ...	Tait Brothers, proprietors.
Wachusett Creamery, .	Worcester, ...	E. H. Thayer & Co., proprietors.
D. Whiting & Sons, . .	Boston, 570 Rutherford Avenue, .	George Whiting.

Milk Laboratory.

Walker-Gordon Laboratory,	Boston, 793 Boylston Street, . .	George W. Franklin.

Receiving Depots for Milk, for Shipments to New York City.

The Borden Company of New York.	West Stockbridge, ...	F. H. Glass.
Willow Brook Dairy Company.	Sheffield, ...	Frank Percy.

Expenses.

The following is a classified statement of the expenses for the year ending Nov. 30, 1911: —

Bureau: compensation and traveling expenses, . .	$636 71
Agents: compensation, ...	2,418 00
Agents: traveling expenses and samples purchased, .	2,931 00
General agent: traveling and necessary expenses, .	483 31
Chemists: analyses, tests, court attendance, . . .	1,158 60
Printing and supplies, ...	127 99
Educational, ...	219 39
Total, ...	$7,975 00

P. M. HARWOOD,
General Agent.

Accepted and adopted as the report of the Dairy Bureau,

CHARLES M. GARDNER.
H. A. PARSONS.
GEO. W. TRULL.

EIGHTH ANNUAL REPORT

OF THE

STATE FORESTER.

Synopsis Presented to the Board and Accepted,
January 9, 1912.

The first power truck sprayer ever invented. Built by the Massachusetts State Forester in 1911 for spraying in the gypsy and brown-tail moth work. The whole outfit was designed and built for this work, and promises to revolutionize the question of spraying, particularly roadside, park and shade tree work, in combating insect and fungous depredations. It can be used for forest fire work as well. The same engine that propels the truck also imparts the power for spraying. See description elsewhere.

EIGHTH ANNUAL REPORT OF THE STATE FORESTER.

Introduction.

It has been the constant aim of the State Forester to establish a forest policy worthy of Massachusetts interests. Year by year, through the splendid support given by our public-spirited citizens and various organizations, we have made constant progress. By perusing the annual reports of the State Forester it may be seen that each year the General Court has recognized the importance of the work and has encouraged a steady development.

In submitting this, the eighth annual report, it is certainly a great pleasure to be able to state that, through the generous consideration of the last General Court, we have been able finally to perfect a State-wide forest fire policy that promises very great economy. With an up-to-date patrol and look-out system for forest fires, backed by a strong and efficient town and city forest warden unit of organization, already well established, together with the perfecting and adapting of previous laws, we now can boast of being in a position adequate for natural growth and development.

I am frank to say that there never has been a more wholesome, co-operative interest shown toward this department than during the present season, and this, too, following an apparent misunderstanding on the part of a few of our legislators last session, who finally gave the department their support.

I firmly believe that ultimately Governor Foss's first year's administration will be as noted for its establishment of a State-wide forest fire protective policy as any legislation enacted during the session. When we once can assure our people that forest fires can and will be controlled, there will be little trouble to interest capital in reforestation. With fire protection and a rapidly increasing interest in modern forestry, which no one can deny is

prevalent even at present, it only remains for the casual observer to predict what we may be able to accomplish in Massachusetts.

The various lines of work in this department have been explained quite fully in past reports, and it is necessary only to state that the work throughout the year has even surpassed any other. The requests for examinations and advice have been far in excess of our ability to meet them with our present force. Forestry literature has been in great demand, and several bulletins have been revised and reprinted, besides much new material sent out. Lectures and demonstrations have been constantly requested, and as many given as conditions would permit. Forest laws and fire-warning posters have been posted fully by our wardens throughout the State.

Towns generally are awakening to the necessity of being equipped with modern fire-fighting apparatus if they are to encourage forestry in their midst. The towns with a valuation of $1,500,000 or less are taking advantage of the State's offer of assistance, and it is predicted that the usual appropriation by the State of $5,000 will be utilized immediately following the spring town meetings. As usual, those towns with equipment and organization have kept forest fires under control, while other towns have suffered.

The work of reforestation continues as popular as ever, and I am convinced that if the Legislature could see its way clearly to enlarge greatly the present appropriation for this work, we could readily plant many times our present annual acreage. Our reforestation act is unique and is proving a success. The work in this line will be far better appreciated in a few years, when the young trees have grown to a more desirable size.

The gypsy and brown-tail moth work, while still a very perplexing problem, is better understood and more intelligently combated than ever. Our people are finding out that the best way to fight these pests is to take advantage of the advice and assistance that experience has taught us. This office is in a position to advise and assist in this work throughout the infested territory. The division superintendents are men of ripe experience, and the local superintendents are more efficient and in better control of their conditions than ever before.

If, as we now have reason to believe, it is soon to come to pass that the United States government will take over the parasitic

work which the State has financed up to the present, and also assume the work of controlling the spread of the moth, then our State work will resolve itself down to internal self-preservation in the present infested territory. With this arrangement, I believe the State ought to combat the enemies satisfactorily with decreasing expenditures. Many cities and towns once badly infested are at present, through State aid, in good condition, and now should become self-supporting, and it is the department's purpose to so direct the work that the annual drain upon the State treasury may be lessened as much as possible.

Massachusetts has been the motive force in combating these pests up to the present. In recent years the insects have spread into adjoining States, where little attention to their control has been given, so that now the problem is one of protecting the nation.

It is believed that the national government can ill afford to take other than a more progressive stand in this work. A million dollars a year at present will go farther than a much greater sum later on. It is reasonable to hope that parasites, diseases or natural causes may work to the detriment of these insects, but there are many chances of other sections of the country becoming infested and thereby working great destruction before results from these are realized. At present the only practical means of protection from the spread of this pest is through spraying and other well-known mechanical methods.

The various phases of the State Forester's activities are given more fully under their respective classifications in this report.

Organization.

There have been a number of changes during the year, but the department is fortunate in having intact the same general staff of assistants as last year.

Mr. A. T. Speare, moth disease work, resigned, and Mr. R. M. Colley of Harvard University has succeeded him. Mr. William Reiff, assistant to Professor Wheeler of the Bussey Institute, and who has given the moth disease work part time, has arranged to give the department his whole time for a season. Mr. Charles W. Minot and Mr. Frank A. Bates, who have been connected with the State work for many years as agents, now known as district superintendents, have resigned.

The changes in local forest wardens and moth superintendents in towns and cities have been very few indeed, and this fact results in more satisfactory conditions.

Mr. William W. Colton, division superintendent No. 6, resigned to become city forester of Fitchburg.

The legislation creating a State Fire Warden and establishing look-out stations and a patrol system increases the organization to that extent.

In securing the services of Mr. M. C. Hutchins as State Fire Warden, I am convinced Massachusetts is particularly fortunate. Mr. Hutchins has been in the employ of the New York forest service for seven years, and had charge of one of the most important forest fire divisions of the Adirondacks. He began his services for Massachusetts on August 1, and already the organization is well perfected. We may have every reason to believe that by another season the forest fire menace will be greatly reduced. A report of the fire work will be explained more fully under that title.

The organization of the State Forester's department at present is as follows: —

GENERAL STAFF.

F. W. RANE, B.Agr., M.S.,	State Forester.
H. O. COOK, M.F.,	Assistant Forester.
L. H. WORTHLEY,	Assistant, moth work.
R. S. LANGDELL,	Assistant, reforestation.
M. C. HUTCHINS,	State Fire Warden.
H. F. GOULD, M.F.,	Assistant, forestry management.
F. F. MOON, M.F.,	Assistant, Massachusetts Agricultural College.
WILLIAM REIFF,	Assistant, moth disease work.
R. H. COLLEY,	Assistant, moth disease work.
CHARLES O. BAILEY,	Secretary.
ELIZABETH HUBBARD,	Clerk, bookkeeper.
CHARLOTTE JACOBS,	Clerk, mail and office.
EMILIE RAU,	Stenographer.
JOSEPHA L. GALLAGHER,	Clerk.
JOHN LANERGAN,	Office boy.

CO-OPERATIVE SCIENTIFIC STAFF.

L. O. HOWARD, Ph.D.,	Chief United States Bureau of Entomology, Washington, D. C., parasites and predaceous insects.
THEOBALD SMITH, Ph.B., M.D.,	Professor of Comparative Pathology, Harvard University, diseases of insects.
ROLAND THAXTER, Ph.D.,	Professor of Cryptogamic Botany, Harvard University, fungous diseases affecting insects.
W. M. WHEELER, Ph.D.,	Professor of Entomology, Harvard University, experimental entomologist.

Staff, Forest Fire Protection.

F. W. Rane, M.S.,	State Forester.
M. C. Hutchins,	State Fire Warden.
M. E. Fenn,	Assistant.
F. L. Haynes,	District Forest Warden No. 1.
J. J. Shepherd,	District Forest Warden No. 2.
John P. Crowe,	District Forest Warden No. 3.
G. H. Allen,	District Forest Warden No. 4.
John Murdoch, Jr.,	District Forest Warden No. 5.

Observers and Observation Stations.

J. F. Hammond,	Robbin's Hill, Chelmsford.
F. H. Lombard,	Grace Mountain, Warwick.
Herbert Morrisey,	Plymouth.
——— ———	Shoot Flying Hill, Barnstable.
G. W. Sherman,	Steerage Rock, Brimfield.
G. C. Miller,	Mount Tom, Holyoke.
N. C. Woodward,	Massamet Mountain, Shelburne Falls.
J. H. Allen,	Wachusett Mountain, Princeton.
L. A. Wells,	Blue Hills, Hyde Park.

Staff, Moth Work.

F. W. Rane, M.S.,	State Forester.
L. H. Worthley,	Assistant (General Superintendent).

Smith, George A., Superintendent, District 1, 92 Sagamore Avenue, Chelsea.
Enwright, John W., Superintendent, District 2, 48 Fellsway, Medford.
Hatch, William A., Superintendent, District 3, 174 Main Street, Hudson.
Ramsey, Harry B., Superintendent, District 4, 217 Park Avenue, Worcester.
Worthen, Francis C., Superintendent, District 5, Central Street, Georgetown.
Fitzgerald, John J., Superintendent, District 6, 50 Howard Street, Haverhill.
Phillips, Saul, Superintendent, District 7, P. O. Box 1363, Beverly.
Parkhurst, Clarence W., Superintendent, District 8, P. O. Box 472, Medfield.
Hodgkins, Lewis W., Superintendent, District 9, North Raynham.
Farley, John A., Superintendent, District 10, Plymouth, R. F. D.
Carleton, John F., Superintendent, District 11, East Sandwich.

Inspectors.

Armstrong, Henry F.
Holmes, Walter F.
Merrick, John L.
Sands, George A.
Silva, Joseph.
Sweeney, Charles F.
Young, Arthur W.

Mechanics.

Halpin, Frederick P.
Perry, Charles H.
Towle, Claude E.
Smith, Albert E.
Wright, Harvey J.

Learoyd, Francis V., in charge, Supply Store.

List of Forest Wardens and Local Moth Superintendents.

[Alphabetically by Towns and Cities.]

Badge No.	Telephone Number.	Forest Warden.	City or Town.	Local Moth Superintendent.	Dist. No.
287	No telephone,	B. E. Wilkes,[1] . .	Abington, . .	C. F. Shaw, .	10
181	No telephone,	W. H. Kingsley, .	Acton, . . .	J. O'Neil, . .	3
275	2003-M, . .	H. F. Taber, . .	Acushnet, . .	A. P. R. Gilmore,	9
7	48-2, . .	J. Clancy, . . .	Adams, . .	– –	–
93	3165-11, . .	E. M. Hitchcock, .	Agawam, . .	– –	–
24	151-32, Great Barrington.	J. H. Wilcox, P. O. State Line.	Alford, . .	– –	–
228	–	J. E. Feltham, . .	Amesbury, . .	A. L. Stover, .	5
67	343-5, . .	A. F. Bardwell, . .	Amherst, . .	W. H. Smith, .	4
212	105-3, . .	J. H. Playdon,[2] .	Andover, . .	J. H. Playdon, .	6
193	35, . .	W. H. Pierce,[1] . .	Arlington, . .	W. H. Bradley, .	2
104	5-6, . .	C. A. Billings, . .	Ashburnham, .	C. A. Billings, .	3
158	–	W. S. Green, . .	Ashby, . .	H. A. Lawrence, .	3
50	4-12, . .	C. A. Hall, . .	Ashfield, . .	– –	–
200	146-L, South Framingham	H. H. Piper, . .	Ashland, . .	M. Geoghan, .	8
105	44-2 or 72-4, .	F. P. Hall,[1] . .	Athol, . . .	W. S. Penniman,	4
265	34-4, . .	H. R. Packard,[1] .	Attleborough, .	W. E. S. Smith, .	8
123	5-17, . .	J. F. Searle, . .	Auburn, . .	J. F. Searle, .	-
259	8072-4, . .	J. W. McCarty, . .	Avon, . . .	W. W. Beals, .	8
169	96-4 or 477-4,	C. E. Perrin, . .	Ayer, . . .	D. W. Mason, .	3
315	236-2, . .	H. C. Bacon, P. O. Hyannis.	Barnstable, .	H. C. Bodfish, .	10
142	8-4, . .	A. E. Traver, . .	Barre, . . .	G. R. Simonds, .	4
23	3-12, . .	E. D. Ballou, . .	Becket, . .	– –	–
179	No telephone,	C. E. Williams, . .	Bedford, . .	W. A. Cutler, .	2
73	10, . .	J. A. Peeso, . .	Belchertown, .	E. C. Howard, .	4
326	157-2, Milford,	J. A. Spencer, . .	Bellingham, .	H. A. Whitney, .	8
194	409-W, . .	J. F. Leonard,[1] . .	Belmont, . .	C. H. Houlahan,	1
271	No telephone,	G. H. Babbitt, Taunton, R. F. D., 1.	Berkley, . .	J. M. Alexander, .	9
139	14-6, . .	W. Cole, . . .	Berlin, . . .	E. C. Ross, . .	3
39	2-13, . .	E. W. Hale, . .	Bernardston, .	– –	–
220	168-12, . .	R. H. Grant,[1] . .	Beverly, . .	J. B. Brown, .	7
173	22-2, . .	E. N. Bartlett,[1] .	Billerica, . .	W. H. O'Brien, .	6
114	475-L-1, Woonsocket.	T. Reilly, . .	Blackstone, .	A. J. Gibbons, .	8
81	10-3, . .	H. K. Herrick, . .	Blandford, . .	– –	–
146	7-22, . .	C. E. Mace, . .	Bolton, . .	C. E. Mace, .	3
–	–	– –	Boston, . .	D. H. Sullivan,	1

[1] Also chief of fire department. [2] Also tree warden.

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

Badge No.	Telephone Number.	Forest Warden.	City or Town.	Local Moth Superintendent.	Dist. No.
311	-	S. O. Phinney, P. O. Monument Beach.	Bourne, . .	S. B. Wright, .	11
182	11-4, W. Acton,	M. L. Wetherbee, .	Boxborough, .	C. E. Sherry, .	3
218	-	H. L. Cole, Georgetown, R. F. D.	Boxford, . .	C. Perley, . .	5
138	16-5, . .	C. S. Knight, . .	Boylston, . .	E. H. Hastings, .	4
244	2125-4, . .	J. M. Cutting, South Braintree.	Braintree, . .	O. A. Hubbard, .	1
318	No telephone,	T. B. Tubman, . .	Brewster, . .	J. E. Eldridge, .	11
293	8-6, . .	E. S. Rhoades, . .	Bridgewater, .	A. W. McFarland,	8
99	14-3, . .	G. E. Hitchcock, .	Brimfield, . .	G. E. Hitchcock,	4
286	1041, . .	H. L. Marston,[1] .	Brockton, . .	R. H. Carr, .	8
120	105-3, . .	D. N. Hunter, . .	Brookfield, . .	J. H. Conant, .	4
237	376, . .	G. H. Johnson,[1] .	Brookline, . .	E. B. Dane, .	1
49	Lampson & Goodnow Mfg. Co.	W. Sauer, P. O. Shelburne Falls.	Buckland, . .	- -	-
178	2-5, . .	W. W. Skelton,[2] .	Burlington, .	W. W. Skelton, .	2
249	21060, . .	L. Horton, P. O. Ponkapoag.	Canton, . .	A. Hemenway, .	8
-	-	- -	Cambridge, .	J. F. Donnelly, .	1
171	9166, . .	W. B. Chamberlain, .	Carlisle, . .	G. G. Wilkins, .	2
304	16-2, . .	H. F. Atwood, . .	Carver, . .	H. F. Atwood, .	10
42	No telephone,	F. D. Legate, . .	Charlemont, .	- -	-
115	32-3, . .	C. Bond, . . .	Charlton, . .	J. D. Fellows, .	4
320	11-12, . .	G. W. Ryder, West Chatham.	Chatham, . .	G. B. Bassett, .	11
172	1597-4, . .	A. C. Perham, . .	Chelmsford, .	M. A. Bean, .	6
-	-	- -	Chelsea,[3] . .	J. A. O'Brien, .	1
11	167-3, . .	C. D. Cummings, .	Cheshire, . .	- -	-
80	8-2, . .	M. E. Turner, . .	Chester, . .	- -	-
63	8004, . .	C. A. Bisbee, Bisbee,	Chesterfield, .	- -	-
87	271-11, . .	M. J. Lynch, . .	Chicopee, . .	- -	-
308	No telephone,	E. C. Mayhew, . .	Chilmark, . .	A. S. Tilton, .	11
3	No telephone,	D. W. Blanchard, No. Adams, R. F. D., 1.	Clarksburg, .	- -	-
145	138-L, . .	R. Jendricks, . .	Clinton, . .	J. B. Connery, .	3
246	177-3, . .	W. J. Brennock, .	Cohasset, . .	J. E. Grassie, .	1
37	17-6, . .	W. H. Davenport, .	Colrain, . .	- -	-
180	169-2 or 300, .	G. G. Morrell,[1] . .	Concord, . .	H. P. Richardson,	1
51	20-13, . .	C. Parsons,[2] . .	Conway, . .	- -	-
60	8001, . .	W. S. Gabb, P. O. Swift River.	Cummington, .	- -	-
14	58-11, . .	A. K. Cleveland, .	Dalton, . .	- -	-
147	No telephone,	T. L. Thayer, North Dana.	Dana, . . .	T. L. Thayer, .	4

[1] Also chief of fire department. [2] Also tree warden. [3] No forest area.

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

Badge No.	Telephone Number.	Forest Warden.	City or Town.	Local Moth Superintendent.	Dist. No.
345	277-3,	M. H. Barry,	**Danvers,**	T. E. Tinsley,	7
278	1383-41, New Bedford.	S. P. Hawes,	**Dartmouth,**	– –	–
241	373 or 31-6,	H. J. Harrigan,	**Dedham,**	J. T. Kennedy,	8
52	273-14, Green,	W. L. Harris,	**Deerfield,**	– –	–
317	No telephone,	A. P. Baker, South Dennis.	**Dennis,**	H. H. Sears,	11
272	29-3,	Ralph Earle,	**Dighton,**	D. F. Lane,	10
112	East Douglas, Central.	W. L. Church,	**Douglas,**	W. E. Carpenter,	4
240	373-1,	J. Breagy,	**Dover,**	H. L. McKenzie,	8
163	1869-4,	F. H. Gunther,[1] Navy Yard.	**Dracut,**	T. F. Carrick,	1
110	152-2,	F. A. Putnam,	**Dudley,**	I. H. Easterbrook,	4
161	No telephone,	A. W. Swallow,	**Dunstable,**	W. Saville,	6
303	22-2,	E. W. Soule, P. O Box 15, Millbrook.	**Duxbury,**	H. A. Fish,	10
298	146-5,	R. H. Copeland, P. O. Elmwood.	**E. Bridgewater,**	B. F. Taylor,	8
95	4-3,	E. J. Speight,	**E. Longmeadow,**	– –	
322	26-21, Orleans,	W. H. Nickerson,	**Eastham,**	N. P. Clark,	
77	2-11,	J. M. Deneen,	**Easthampton,**	– –	
264	24-7, North Easton.	J. Baldwin,[1]	**Easton,**	R. W. Melendy,	8
346	241-2,	M. S. Roberts,	**Edgartown,**	T. S. Wimpenny,	8
29	165-14, Great Barrington.	F. W. Bradford, Great Barrington, R.F.D.	**Egremont,**	– –	–
74	1-13,	H. L. Ryther,	**Enfield,**	– –	–
46	No telephone,	C. H. Holmes, Farley,	**Erving,**	– –	–
233	No telephone,	O. O. Storey,[2]	**Essex,**	O. O. Story,	7
–	–	– –	**Everett,**[3]	J. Davidson,	2
276	1439-22,	A. C. Aiken,	**Fairhaven,**	G. W. King,	9
280	14,	W. Mulligan,	**Fall River,**	J. H. Nugent,	9
312	136-2,	H. N. Lawrence, P. O. Teaticket.	**Falmouth,**	W. B. Bosworth,	11
157	1421-W or 745,	W. W. Colton,	**Fitchburg,**	W. W. Colton,	3
5	Hoosac Tunnel Pay Station.	H. B. Brown, P. O. Drury.	**Florida,**	– –	–
261	37-11,	E. A. White,[1]	**Foxborough,**	S. J. Johnston,	8
197	352-4, South Framingham	B. P. Winch,	**Framingham,**	N. I. Bowditch,	8
255	67-3,	E. S. Cook,	**Franklin,**	J. W. Stobbart,	8
274	No telephone,	A. Hathaway, Assonet,	**Freetown,**	G. M. Nichols,	11
153	191-M,	G. S. Hodgman,	**Gardner,**	T. W. Danforth,	4
343	–	L. B. Smalley, P. O. Menemsha.	**Gay Head,**	J. W. Belain,	11
224	4-2,	C. J. Eaton,	**Georgetown,**	C. J. Eaton,	5
45	4-15,	L. C. Munn,	**Gill,**	A. Tuttle,	4
234	547-5,	S. F. Haskell,	**Gloucester,**	H. J. Worth,	7

[1] Also chief of fire department. [2] Also tree warden. [3] No forest area.

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

Badge No.	Telephone Number.	Forest Warden.	City or Town.	Local Moth Superintendent.	Dist. No.
61	18-4, . .	J. S. Mollison, P. O. Williamsburg.	**Goshen,** . .	- -	-
344	-	- -	**Gosnold,** . .	- -	-
125	Central, .	S. F. Leonard, . .	**Grafton,** . .	C. K. Despeau, .	4
79	55-4, . .	C. N. Rust, . .	**Granby,** . .	- -	-
91	4-12, . .	L. N. Henry, . .	**Granville,** . .	- -	-
25	5-3, . .	D. W. Flynn, . .	**Gt. Barrington,**	- -	-
44	443-2, . .	J. W. Bragg, . .	**Greenfield,** . .	J. W. Bragg, .	4
327	33-24, . .	W. H. Walker, Greenwich Village.	**Greenwich,** .	- -	-
167	105, . .	J. B. Harrington,[1] .	**Groton,** . .	J. F. Bateman, .	2
225	1026-X, . .	S. E. Johnson, . .	**Groveland,** . .	R. B. Larive, .	5
66	651-33, Northampton.	E. P. West,[2] . .	**Hadley,** . .	- -	-
299	-	E. H. Vaughn, . .	**Halifax,** . .	F. D. Lyon, .	10
222	No telephone,	F. Berry, Essex, R. F. D.	**Hamilton,** . .	E. G. Brewer, .	7
97	6-5, . .	J. S. Swenson, . .	**Hampden,** . .	- -	-
9	Post-office, .	C. F. Tucker, . .	**Hancock,** . .	- -	-
295	8011-2, . .	C. E. Damon, Box 113, No. Hanover.	**Hanover,** . .	L. Russell, . .	10
296	8012-6, Bryantville.	A. L. Dame,[2] South Hanson.	**Hanson,** . .	A. L. Dame, .	10
141	No telephone,	P. J. Humphrey, .	**Hardwick,** . .	P. J. Humphrey,	4
152	46-3, . .	B. J. Priest, . .	**Harvard,** . .	G. C. Maynard, .	3
319	Central, .	J. Condon, . .	**Harwich,** . .	- -	-
65	6-3, . .	J. M. Strong, West Hatfield.	**Hatfield,** . .	- -	-
216	4-2, . .	J. B. Gordon,[1] . .	**Haverhill,** . .	M. Fitzgerald, .	6
48	121-3, . .	M. H. White, P. O. Charlemont.	**Hawley,** . .	- -	-
36	5-18, . .	S. G. Benson, . .	**Heath,** . .	- -	-
289	21305, . .	G. Cushing,[1] . .	**Hingham,** . .	T. L. Murphy, .	1
15	20, . .	L. B. Brague, . .	**Hinsdale,** . .	- -	-
247	150, Randolph,	E. W. Austin,[1] . .	**Holbrook,** . .	W. Hayden, .	8
136	29-4, . .	W. H. Stearns, P. O. Jefferson.	**Holden,** . .	W. H. Stearns, .	4
101	5-21, . .	O. L. Howlett, Southbridge, R.F.D.	**Holland,** . .	- -	-
202	1-2, . .	W. A. Collins, . .	**Holliston,** . .	G. H. Moody, .	8
85	R. H. Dietz, .	C. J. Haley, . .	**Holyoke,** . .	- -	-
328	233-2, . .	W. F. Durgin, . .	**Hopedale,** . .	W. F. Durgin, .	8
201	Central, .	R. I. Frail, . .	**Hopkinton,** .	W. McMillan, .	8
149	25-13, . .	E. A. Young,[2] . .	**Hubbardston,** .	E. A. Young, .	4
199	No telephone,	F. W. Trowbridge,[1] .	**Hudson,** . .	F. P. Hosmer, .	3
329	248-W, . .	S. F. Sturges,[2] P. O. Allerton.	**Hull,** . . .	J. Knowles, .	1
70	-	D. B. Mack, . .	**Huntington,** .	- -	-

[1] Also chief of fire department. [2] Also tree warden.

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

Badge No.	Telephone Number.	Forest Warden.	City or Town.	Local Moth Superintendent.	Dist. No.
330	28 or 156, .	J. H. Wetherbee, .	**Hyde Park,** .	E. I. Corbett, .	1
223	42-6 or 100, .	A. J. Barton, . .	**Ipswich,** . .	J. Morey, . .	5
301	-	A. B. Holmes, . .	**Kingston,** . .	R. F. Randall, .	10
283	261-2, . .	N. F. Washburn, P. O. Middleborough.	**Lakeville,** . .	S. T. Nelson, .	9
151	152-3, Clinton,	E. M. Hawkins, .	**Lancaster,** . .	L. R. Griswold, .	3
10	717-5, Pittsfield.	K. D. Keeler, . .	**Lanesborough,** .	- -	-
214	24-M, . .	H. Roach, . . .	**Lawrence,** . .	H. Roach, . .	6
22	66-5, . .	J. W. Bossidy, . .	**Lee,** . . .	- -	-
122	No telephone,	C. White, P. O. Cherry Valley.	**Leicester,** . .	J. H. Woodhead, .	4
18	135, . .	O. R. Hutchinson,[1] .	**Lenox,** . . .	M. O'Brien, .	4
155	546 or 9, .	F. A. Russell, . .	**Leominster,** .	S. R. Walker, .	3
57	No telephone,	O. C. Marvel, North Leverett.	**Leverett,** . .	- -	-
188	No telephone,	A. P. Howe, . .	**Lexington,** . .	A. P. Howe, .	2
38	248-11, . .	J. Sauter, . . .	**Leyden,** . .	- -	-
187	56-5, . .	J. J. Kelliher, Concord, R. F. D.	**Lincoln,** . .	J. J. Kelliher, .	1
170	17-4, . .	A. E. Hopkins, . .	**Littleton,** . . .	A. E. Hopkins, .	3
94	1233-2, . .	O. C. Pomeroy, . .	**Longmeadow,** .	- -	-
165	201-21, . .	E. S. Hosmer,[1] . .	**Lowell,** . .	C. A. Whittet, .	6
88	17-13, . .	E. E. Chapman, .	**Ludlow,** . .	- -	-
156	24-2 L, . .	M. E. Harvey, . .	**Lunenburg,** .	M. E. Harvey, .	3
331	1174, . .	H. C. Bayrd, . .	**Lynn,** . . .	G. H. McPhetres,	1
209	No telephone,	T. E. Cox, Wakefield, R. F. D.	**Lynnfield,** . .	L. P. Twiss, .	2
191	108, . .	F. Turner, . .	**Malden,** . .	Street commissioners.	-
236	-	E. J. Seamans, . .	**Manchester,** .	J. D. Morrison, .	7
263	1-2, . .	H. E. King, . .	**Mansfield,** . .	W. O. Sweet, .	8
332	No telephone,	W. H. Stevens, . .	**Marblehead,** .	W. H. Stevens, .	1
306	117-2, . .	G. B. Nye, . .	**Marion,** . .	J. Allanack, .	11
198	345-2, . .	E. C. Minehan,[1] .	**Marlborough,** .	T. J. Brennan, .	3
292	43-3, . .	W. G. Ford, . .	**Marshfield,** . .	P. R. Livermore,	10
313	19-11 or 19-4, Cotuit.	J. A. Peters, . .	**Mashpee,** . .	W. F. Hammond,	11
281	25-2, . .	E. C. Stetson, . .	**Mattapoisett,** .	A. H. Dexter, .	9
184	No telephone,	A. J. Coughlan, . .	**Maynard,** . .	A. Coughlan, .	3
252	106-4, . .	W. E. Kingsbury,[1] .	**Medfield,** . .	G. L. L. Allen, .	8
192	138 or 53, .	C. E. Bacon,[1] . .	**Medford,** . .	W. J. Gannon, .	1
254	15-2 or 38-3, .	C. C. Hunt, . .	**Medway,** . .	F. Hager, . .	8
-	-	- -	**Melrose,** . .	J. J. McCullough,	2
118	151-4, . .	E. L. Cook, . .	**Mendon,** . .	F. M. Aldrich, .	8

[1] Also chief of fire department.

List of Forest Wardens and Local Moth Superintendents — *Con.*

Badge No.	Telephone Number.	Forest Warden.	City or Town.	Local Moth Superintendent.	Dist. No.
227	21-3, .	E. P. Sargent, . .	**Merrimac,** . .	C. R. Ford, .	5
213	No telephone,	H. Nichols, . .	**Methuen,** . .	A. H. Wagland, .	6
284	5 or 36, . .	C. E. Weston, . .	**Middleborough,** .	F. L. White, .	9
342	9024-14, . .	T. H. Flemming, P. O. Bancroft.	**Middlefield,** .		–
211		O. H. Sheldon, . .	**Middleton,** . .	B. T. McGlauflin,	5
127	65-3, . .	E. M. Crockett,[1] .	**Milford,** . .	P. Fitzgerald, .	8
124	42-13, . .	W. Blany, . . .	**Millbury,** . .	E. F. Roach, .	4
253	5-2, . .	C. La Croix, . .	**Millis,** . . .	E. W. Stafford, .	8
242	322, . .	N. T. Kidder,[2] . .	**Milton,** . .	N. T. Kidder, .	1
34	No telephone,	S. R. Tower, . .	**Monroe,** . .	– –	–
98	12-22, . .	O. E. Bradway, .	**Monson,** . .	– –	–
53	289-14, Greenfield.	F. T. Lyman, . .	**Montague,** . .	– –	–
28	Post-office, .	D. C. Tryon, . .	**Monterey,** . .	– –	–
30	No telephone,	R. I. Patterson, .	**Mt. Washington,**	– –	–
–	138, . .	T. Roland, . .	**Nahant,**[3] . .	T. Roland, . .	1
333	16-21, . .	G. M. Winslow, . .	**Nantucket,** .	G. M. Winslow, .	11
204	52-4, . .	W. E. Daniels, . .	**Natick,** . .	H. S. Hunnewell,	1
238	195-1, . .	H. H. Upham,[1] .	**Needham,** . .	E. E. Riley, .	1
6	No telephone,	C. S. Baker, . .	**New Ashford,** .	– –	–
277	2280, . .	E. F. Dahill,[1] . .	**New Bedford,** .	C. F. Lawton, .	9
131	31-15, North Brookfield.	E. L. Havens, . .	**New Braintree,** .	E. L. Havens, .	4
32	Post-office, .	J. McLaughlin, . .	**N. Marlborough,**	– –	–
55	Pay station, .	R. King, Cooleyville,	**New Salem,** .	R. King, . .	4
231	173-1, Newburyport.	W. P. Bailey, Byfield,	**Newbury,** . .	H. L. Bailey, .	5
230	380, . .	C. P. Kelley, . .	**Newburyport,** .	C. P. Kelley, .	5
205	N. W., 33-1, .	W. B. Randlett,[1] Newton Center.	**Newton,** . .	C. I. Bucknam, .	1
256	Post-office, .	A. R. Jones, . .	**Norfolk,** . .	A. R. Jones, .	8
4	205-4, . .	H. J. Montgomery,[1] .	**North Adams,** .	H. E. Blake, .	4
215	821-3, . .	G. A. Rea, . .	**North Andover,** .	P. Holt, . .	6
262	17-2, . .	H. W. Tufts, . .	**N. Attleborough,**	F. P. Toner, .	8
129	26-14, . .	G. O. Rollins,[1] . .	**N. Brookfield,** .	S. D. Colburn, .	4
175	12-6, . .	H. Upton,[1] . .	**North Reading,** .	G. E. Eaton, .	2
72	165, . .	F. E. Chase, Engine House.	**Northampton,** .	– –	–
140	14-5, . .	T. P. Haskell, . .	**Northborough,** .	T. P. Haskell, .	4
117	71-5, Whitinsville.	W. E. Burnap, P. O. Whitinsville.	**Northbridge,** .	– –	–
40	2-3, . .	F. W. Doane, . .	**Northfield,** . .	F. W. Doane, .	4
266	No telephone,	G. H. Storer, . .	**Norton,** . .	G. H. Storer, .	8

[1] Also chief of fire department. [2] Also tree warden. [3] No forest area.

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

Badge No.	Telephone Number.	Forest Warden.	City or Town.	Local Moth Superintendent.	Dist. No.
290	11-4,	J. Whalen,	**Norwell,**	J. H. Sparrell,	10
250	–	J. Fred Boyden,	**Norwood,**	F. H. Winslow,	8
334	119-4, Marthas Vineyard.	F. W. Chase,	**Oak Bluffs,**	P. P. Hurley,	11
135	17-5,	C. H. Trowbridge,	**Oakham,**	C. H. Trowbridge,	4
47	62-13,	F. M. Jennison,	**Orange,**	F. M. Jennison,	4
321	21-12,	C. F. Poor,	**Orleans,**	A. Smith,	11
27	7-15,	J. B. Soule, East Otis,	**Otis,**	– –	–
335	25-2,	C. A. Rich,	**Oxford,**	C. G. Larned,	4
89	65-11 or 53-12,	J. Summers,[1]	**Palmer,**	C. H. Keith,	4
130	881-14, Worcester.	D. W. Gratan,	**Paxton,**	F. L. Durgin,	4
219	18-3,	M. V. McCarthy,	**Peabody,**	J. F. Callahan,	2
68	318-2,	G. P. Shaw, Amherst, R. F. D.	**Pelham,**	– –	–
294	8029-2, Bryantville.	J. J. Shepard,	**Pembroke,**	J. J. McFarlen,	10
160	54-3 or 12-5,	G. G. Tarbell, East Pepperell.	**Pepperell,**	J. Tune,	2
16	1-2,	E. Shumway,	**Peru,**	– –	–
148	13-2,	G. P. Marsh,[2]	**Petersham,**	F. A. Hathaway,	4
106	176-6, Athol,	W. Coulbeck, Athol, R. F. D., 3.	**Phillipston,**	W. H. Coulbeck,	4
13	149 or 964,	W. C. Shepard,[1]	**Pittsfield,**	– –	–
309	18-31, Cumming.	E. L. Parker,	**Plainfield,**	– –	–
59	208-L, No. Attleborough.	H. E. Coombs,[1]	**Plainville,**	C. N. Snell,	8
302	197-W or 88-4,	H. Morissey,	**Plymouth,**	A. A. Raymond,	10
300	11-14, Kingston.	T. W. Blanchard,	**Plympton,**	D. Bricknell,	10
69	11-4,	W. H. Pierce, P. O. Greenwich Village.	**Prescott,**	– –	–
150	13-4,	F. W. Bryant,	**Princeton,**	F. A. Skinner,	4
325	49-11,	J. H. Barnett,	**Provincetown,**	J. M. Burch,	–
243	–	P. J. Williams,[1]	**Quincy,**	A. J. Stewart,	1
248	86-1,	C. A. Wales,[1]	**Randolph,**	J. E. Blanche,	8
270	1284-R,	J. V. Festing,	**Raynham,**	G. M. Leach,	9
176	214-1,	H. E. McIntire,	**Reading,**	H. M. Donegan,	2
268	11-12,	B. F. Monroe, Attleborough, R. F. D.	**Rehoboth,**	S. W. Robinson,	9
–	–	– –	**Revere,**[3]	G. P. Babson,	1
17	4-2,	T. B. Salmon,	**Richmond,**	– –	–
282	No telephone,	D. E. Hartley, P. O. Mattapoisett.	**Rochester,**	G. W. Wilcox,	11
288	55-4,	J. H. Burke,	**Rockland,**	F. H. Shaw,	10
235	27-3,	A. J. McFarland,	**Rockport,**	F. A. Babcock,	7
35	21-6,	M. A. Peck, P. O. Zoar,	**Rowe,**	– –	–
232	No telephone,	D. O'Brien,	**Rowley,**	D. O'Brien,	5

[1] Also chief of fire department. [2] Also tree warden. [3] No forest area.

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

Badge No.	Telephone Number.	Forest Warden.	City or Town.	Local Moth Superintendent.	Dist. No.
102	No telephone,	L. G. Forbes,	**Royalston,**	A. H. Brown,	4
83	194, Springfield.	S. S. Shurtleff,	**Russell,**	- -	-
143	13-3,	H. Converse,[1]	**Rutland,**	H. E. Wheeler,	4
-	-	- -	**Salem,[3]**	A. Stillman,	7
229	-	C. I. Dow,	**Salisbury,**	H. C. Rich,	5
33	Post-office,	L. H. Clark, P. O. New Boston.	**Sandisfield,**	- -	-
314	-	J. F. Carlton, P. O. Spring Hill.	**Sandwich,**	B. F. Denison,	11
207	144-2,	O. C. Christiansen,	**Saugus,**	T. E. Berrett,	2
8	3-3,	H. H. Fitzroy,	**Savoy,**	- -	-
291	129-3,	E. R. Seaverns,[1] North Scituate.	**Scituate,**	P. S. Brown,	1
267	399-L-5, Pawtucket.	J. L. Baker, Attleborough, R. F. D., 4.	**Seekonk,**	H. L. Thompson,	9
257	121-2,	A. A. Carpenter,	**Sharon,**	T. J. Leary,	8
31	24-2,	A. H. Tuttle,	**Sheffield,**	- -	-
43	135-4,	H. O. Fiske, Shelburne Falls.	**Shelburne,**	- -	-
203	-	M. F. Campbell, So. Sherborn.	**Sherborn,**	J. P. Dowse,	8
348	9-6,	G. F. Buxton,	**Shirley,**	A. A. Adams,	3
132	Central,	W. E. Rice,	**Shrewsbury,**	F. L. Ott,	4
58	2-21 Highland Tel. Co.	M. A. Haskell,	**Shutesbury,**	- -	-
336	No telephone,	W. F. Griffiths, Swansea, R. F. D.	**Somerset,**	C. Riley,	9
-	-	- -	**Somerville,[3]**	A. B. Pritchard,	1
78	724-1, Holyoke,	L. H. Lamb, South Hadley Falls.	**So. Hadley,**	- -	-
76	151-22,	G. W. Tyler,	**Southampton,**	- -	-
337	13, Marlborough.	H. Burnett,[2]	**Southborough,**	H. Burnett,	4
109	11,	A. Langevin,	**Southbridge,**	A. Langevin,	4
92	14-5,	L. G. Mason,	**Southwick,**	- -	-
121	77-4,	A. F. Howlett,	**Spencer,**	G. Ramer,	4
86	20, Indian Orchard.	T. J. Clifford, P. O. Indian Orchard.	**Springfield,**	W. F. Gale,	4
144	16-5,	G. F. Herbert, P. O. Pratts Junction.	**Sterling,**	J. H. Kilburn,	3
21	Post-office,	G. Schneyer, P. O. Glendale.	**Stockbridge,**	Dr. H. C. Haven,	4
190	207-R,	L. T. Bruce,	**Stoneham,**	G. M. Jefts,	2
258	121-3,	J. Curley,	**Stoughton,**	W. P. Kennedy,	8
183	145-11,	W. H. Parker, P. O. Gleasondale.	**Stow,**	G. A. Patterson,	3
108	No telephone,	C. M. Clark, P. O. Fiskdale.	**Sturbridge,**	C. M. Clark,	4
185	5-5,	S. W. Hall, So. Sudbury.	**Sudbury,**	W. E. Baldwin,	3
338	46,	A. C. Warner,	**Sunderland,**	- -	-
116	56-5, Millbury,	R. H. Richardson,	**Sutton,**	J. E. Gifford,	4
339	3106-3,	G. P. Cahoon,[1]	**Swampscott,**	E. P. Mudge,	1

[1] Also chief of fire department. [2] Also tree warden. [3] No forest area.

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

Badge No.	Telephone Number.	Forest Warden.	City or Town.	Local Moth Superintendent.	Dist. No.
273	–	T. L. Mason,	Swansea,	A. E. Arnold,	9
269	320 or 1-3,	F. A. Leonard,[1]	Taunton,	A. Harnden,	9
107	37-16,	H. A. Seaver,	Templeton,	J. B. Wheeler,	4
164	11-3,	H. W. Pillsbury,	Tewksbury,	H. M. Briggs,	6
310	102-3,	E. C. Chadwick, P. O. Vineyard Haven.	Tisbury,	P. S. Luce,	11
90	–	C. H. Deming,	Tolland,	– –	–
218	Central,	C. W. Floyd,	Topsfield,	C. W. Floyd,	5
159	11-2 or 37-2,	F. J. Piper,[1]	Townsend,	G. E. King,	2
324	No telephone,	N. Hatch,	Truro,	J. H. Atwood,	11
162	6-4,	O. L. Wright,	Tyngsborough,	C. Allgrove,	6
26	1-22,	G. F. Knapp,	Tyringham,	– –	–
126	7-2,	E. M. Baker,[1]	Upton,	G. H. Evans,	8
113	31-12,	L. F. Rawson,	Uxbridge,	H. C. Newell,	8
208	–	S. T. Parker,	Wakefield,	W. W. Whittredge,	2
100	No telephone,	W. W. Eager,	Wales,	– –	–
340	112-2,	H. A. Spear, Jr.,	Walpole,	P. R. Allen,	8
195	Post-office,	G. L. Johnson,[1]	Waltham,	W. M. Ryan,	1
75	5-13,	L. S. Charbonneau,	Ware,	F. Zeissig,	4
305	45-23,	D. C. Keyes,	Wareham,	J. J. Walsh,	11
119	No telephone,	D. Vigneaux,	Warren,	A. A. Warriner,	4
41	73-3,	C. A. Williams,	Warwick,	E. E. Batchelder,	4
19	34-6, Becket,	C. B. Saunders,	Washington,	– –	–
206	116, Newton North.	J. C. Ford,	Watertown,	J. C. Ford,	1
196	56-4, Natick,	C. S. Williams, P. O. Cochituate.	Wayland,	D. J. Graham,	1
111	113-4,	T. Toomey,	Webster,	C. Klebart,	4
239	250,	W. W. Diehl,	Wellesley,	F. M. Abbott,	1
323	No telephone,	E. P. Cook,	Wellfleet,	E. S. Jacobs,	11
54	74-14, Orange,	G. A. Lewis,	Wendell,	– –	–
221	74-2,	J. D. Barnes,[2]	Wenham,	J. D. Barnes,	7
137	4-12,	F. H. Baldwin,	West Boylston,	C. H. Baldwin,	4
285	768,	W. P. Laughton,	W. Bridgewater,	O. Belmore,	8
128	No telephone,	J. H. Webb,	W. Brookfield,	J. H. Webb,	4
226	No telephone,	S. M. Titcomb, P. O. Byfield.	W. Newbury,	W. H. Preble,	5
341	691-12,	A. A. Sibley,	W. Springfield,	J. F. Hayes,	8
20	Post-office,	B. Manning,	W. Stockbridge.	– –	–
307	203-23,	W. J. Rotch,	West Tisbury,	H. W. Athearn,	11
133	No telephone,	J. H. McDonald,[1]	Westborough,	J. P. Crowe,	4

[1] Also chief of fire department. [2] Also tree warden.

LIST OF FOREST WARDENS AND LOCAL MOTH SUPERINTENDENTS — *Con.*

Badge No.	Telephone Number.	Forest Warden.	City or Town.	Local Moth Superintendent.	Dist. No.
81	111-Y,	T. H. Mahoney,	Westfield,	- -	-
166	14-3,	J. A. Healey, P. O. Graniteville.	Westford,	H. L. Nesmith,	2
71	148-13,	L. Burt,	Westhampton,	- -	-
154	15-22,	J. C. Goodridge,	Westminster,	S. Whitney,	4
186	512-2, Waltham.	E. P. Ripley,	Weston,	E. P. Ripley,	1
279	No telephone,	H. A. Sanford,	Westport,	H. A. Sanford,	9
251	336-M, Dedham.	P. R. Dean,	Westwood,	C. H. Southerland,	8
245	332-M,	J. L. Hunt,[1]	Weymouth,	C. L. Merritt,	1
56	69-2, South Deerfield.	J. A. Wood, East Whately.	Whately,	- -	-
297	28-14,	C. A. Randall,[2]	Whitman,	C. A. Randall,	10
96	1-4,	H. I. Edson, North Wilbraham.	Wilbraham,	J. H. Starr,	4
64	37-21,	F. J. Vining, P. O. Haydenville.	Williamsburg,	- -	-
2	184-14,	A. Remillard,	Williamstown,	- -	-
174	34-4,	H. M. Horton,	Wilmington,	O. A. McGrane,	2
103	147-5,	A. L. Brown,[1]	Winchendon,	G. W. Drury,	4
189	123-2,	D. H. DeCarney,[1]	Winchester,	S. S. Symmes,	2
12	203-12, Dalton,	C. D. Galusha,	Windsor,	- -	-
-	-	- -	Winthrop,[3]	J. A. Barry,	1
177	110,	F. E. Tracy,[1]	Woburn,	J. H. Kelley,	2
131	1947,	A. V. Parker	Worcester,	H. J. Neale,	4
62	10-13,	C. F. Bates,	Worthington,	- -	-
260	21-3,	E. S. Stone,	Wrentham,	W. M. Gilmore,	8
316	53-21,	D. Nickerson,	Yarmouth,	C. R. Bassett,	11

[1] Also chief of fire department. [2] Also tree warden. [3] No forest area.

GENERAL FORESTRY.

Examinations of Woodland.

Our custom, continued now for several years, of giving first place under "general forestry" to an account of examinations of woodland belonging to private owners, seems again to be justified by a slight increase over last year, both numerically and in area, of unsolicited examinations of this character, thus keeping this branch of our work well to the front in importance.

Not only has this increase taken place, but, what is still more gratifying, the proportion of examinees who are actually following or are on the point of taking up the recommendations of the office has surpassed that of last year by nearly 10 per cent. An increase of this kind is much more gratifying than would be the increase in number of examinations alone. The total area of land examined exceeds last year's figures by nearly 2,000 acres.

Owing to this increase, as well as to the additional amount of land surveyed and mapped, no systematic attempt has been made to pursue the work of inspecting former examinations, in accordance with the hope expressed last year. Several such inspections have been made in the regular course of the work, however, as will appear below.

The following tables give lists of the examinations and inspections made, their location and area. A table of costs will be found at the end of this section of the report.

Owner.	Town.	Area (Acres).
Affleck, G. B.,	Russell,	30
Bay State Street Railway Company,	Methuen,	43
Bay State Street Railway Company,	Tyngsborough,	118
Bennett, Marion,	Tyngsborough,	200
Bird, C. S.,	East Walpole,	20
Breague, Dr.,	Foxborough,	5
Brown, Wm. B.,	Blackinton,	400
Bullard,	Holliston,	100
Clark, H. W.,	Andover,	55
Clinton water department,	Sterling,	211
Crocker, C. T.,	Fitchburg and Westminster,	500
Cutting, Mattie B.,	Sudbury,	50
Dennison, H. S.,	Framingham,	20
Fogg, H. T.,	Norwell,	40
Foxborough State Hospital,	Foxborough,	1,000
Greenfield Woman's Club,	Greenfield,	52
Hale, R. W.,	Dover,	180
Hardy, F. O.,	Ashburnham,	200
Hellier, C. E.,	Marion,	20
Holloway, G. W.,	Abington,	18
Holliston school board,	Holliston,	10
Hosmer, E. H.,	Carlisle,	190
Hunt, D.,	Marshfield,	150
Hutchins, G.,	Concord,	6
Leland, P. F.,	Ashland,	14
Maynard & Edgerly,	Stow,	30
Metropolitan Water Board,	Southborough, Framingham, Marlborough.	1,400
Milford, town of,	Milford,	8
Mixter, S. J.,	Hardwick,	250
Mixter, S. J.,	Barre,	101
Mount Tom Golf Club,	Holyoke,	20
New Bedford water works,	Lakeville, Freetown, Rochester,	1,500
Newburyport water board,	Newburyport,	50
New Salem Academy,	New Salem,	102
Norwell, town of,	Norwell,	10
Owen, G. W.,	Peabody,	8
Pabodie, W.,	Walpole,	40
Pearce, A. C.,	Lexington,	6
Perkins, H. S.,	Ipswich,	50
Plumb, C. S.,	Becket,	465

Owner.	Town.	Area (Acres).
Pousland, F. G.,	Carlisle,	70
Powell, E. C.,	Wilbraham,	50
Reed, J. O.,	Townsend,	95
Ripley, A. L.,	Andover,	10
Sibley, F. P.,	Hingham,	62
Stannard, Margaret,	Andover,	40
Stevens estate,	Warwick,	50
Vesper Club,	Tyngsborough,	90
Wakefield park board,	Wakefield,	8
Washburn, C. G.,	Princeton,	6
Watertown Arsenal,	Watertown,	2
Wharton, W. F.,	Groton,	10
White, A. P.,	Danvers,	30
Y. P. C. U. of Lynn,	Lynnfield,	7
Total,		8,202

Ten inspections have been made, totalling 880 acres.

Owner.	Town.	Area (Acres).
Bay State Street Railway Company,	Groveland,	38
Bennett, Marion,	Tyngsborough,	200
Fitchburg water board,	Westminster,	400
Fogg, H. T.,	Norwell,	40
Goldsbury, P. S.,	Warwick,	50
Joslin, E. P.,	Oxford,	100
Kilburn, W. C.,	Lancaster,	7
Leland, P. F.,	Ashland,	14
Mahoney, T. J.,	Wareham,	1
Sears, Julia M.,	Tyngsborough,	30
Total,		880

Chestnut Bark Disease.

In addition to the regular examinations of woodland described above, several examinations have been made by this office to ascertain the presence or absence of the chestnut bark disease, *Diaporthe* (*Valsonectria*) *parasitica*.

A list of examinations follows: —

A natural stand of white pine properly thinned to assure good growth of the remaining trees. In the town of Buckland.

A plantation of white pine, thirty-eight years of age, which has been thinned by this office at a profit, belonging to W. G. Killburn of Lancaster.

Owner.	Town.	Area (Acres).	Disease present.
Helburn, J. W.,	West Stockbridge,	160	No
Hoffman, Bernard,	Stockbridge,	Nursery stock	No
Moses, A. H.,	Russell,	1,200	Yes
Pearson, S. F.,	Alford,	50	Yes
Shatswell, H. K.,	Dedham,	30	No
Woodruff, C.,	West Stockbridge,	75	No

These examinations were made with the knowledge and usually at the request of the owner.

During the coming year this work will be energetically pushed, and in fact at this writing two assistants from this office are in the field investigating the geographical extent of the infestation, following up the work of Mr. A. H. Graves of the United States forest service (outlined more fully in another section of this report), but with particular reference to discovering and investigating all possible means of utilizing the wood of trees killed by the disease, *e.g.*, the comparatively recent process of obtaining chestnut extract from both bark and wood.

Woodland Management.

Some space in our last annual report was devoted to an account of an operation in Buckland, Mass., where a good bit of merchantable timber was taken out and the stand still left in good growing shape, the ground being well covered in most cases with white pine seed trees. Where such seed trees were not left, under planting with two-year seedlings was tried.

The success of this operation has made us feel justified in undertaking the general supervision of a similar work in Barre, described fully below.

Surveying.

The forestry department has done more surveying and accompanying mapping this year than ever before. The work of obtaining complete files of maps for all lots taken over under the so-called reforestation act is being carried to completion. During the past year an area of 485 acres has been thus surveyed, comprising the following lots: —

Name of Lot.	Town.	Area (Acres).
Baker-Dune,	Wellfleet,	18
Bolton,	Shirley,	20
Crowell,	Yarmouth,	21
French,	Lancaster,	74
Holmes,	Kingston,	14
Holway,	Sandwich,	24
Glebe land,	Hopkinton,	108
Jacobs,	Wellfleet,	6
Jones River,	Kingston,	140
Nickerson,	Harwich,	15
Clark,	Paxton,	45
Total,		485

Other lots surveyed bring the total area up to 643 acres, for all of which maps have been made by the forestry department.

Forest Maps.

Besides maps of this sort, two complete maps in colors have been made. One of these, a map of the Barre property above referred to, comprises an area of 101 acres, and outlines the various types of tree growth, forming a basis for an estimate of the timber and a working plan for carrying on the operation of the property.

Before this map was drawn a so-called preliminary examination was made to ascertain the approximate amount of timber and the chances of getting it out, accompanied by a report recommending that certain steps be taken toward ascertaining the facts more accurately, and particularly in regard to the making of the map in question.

This report being accepted and its suggestions adopted, several days were spent in an accurate survey of the ground and in plotting the areas of the different types of growth as closely as possible. The map when finished was made the basis of a fuller report, containing the volume to be removed by cutting and an estimate of the gross and net profits.

The pine was found to total about 1,750,000 feet board measure, of which some 750,000 feet will be cut. Of the 245,000 feet of hardwood, about 153,000 feet will be cut. Besides the above

there is on the property about 54,000 feet of hemlock, so that it will be evident that a fair-sized timber operation is under way, and one which will illustrate, we hope, the advantages of a scientific method of cutting, — a statement which becomes particularly forcible when it is added that a probable net profit of about $7,000 will be realized and the stand left in better growing shape at the conclusion of the work than it was in the beginning.

The operation of this lot is now in progress and the work is nearing completion, a large number of the logs being yarded and ready for the mill. This office hopes in the near future to publish a bulletin describing in some detail this operation, and several others recently handled in much the same way.

The other map referred to combines an outline survey with timber and topographic map in colors, and, like the above, is accompanied by an estimate. The property is owned by Prof. C. S. Plumb of Columbus, O., and consists of 450 acres of land in Becket, Mass., most of which is growing some kind of timber. Mr. Plumb has become much interested in the property, and we hope by judicious forestry management to eventually establish a good working forest proposition. To this end the owner expects to turn over 10 acres of the open land, and probably more eventually, for forest planting. This will supply the immediate need for young growth, and if continued at intervals will provide constantly growing timber of different ages. About all the other stages of growth are now represented by timber on the ground, although the proportions vary greatly, as is to be expected in any natural stand.

If our plans are followed, however, instead of eventually being obliged to cut practically all the timber and leave the ground bare, by the time the present medium growth is mature there will be a fine stand of much better quality coming on.

Thus the ideal of all forest management will be approached, viz., a continuous, periodical, sustained yield, without diminution of the capital stock of timber.

All the maps referred to have been preserved in duplicate for our files by means of tracings, thus doubling the work but greatly increasing the usefulness of the maps.

Examination Work.

An account of the expenses of the examination work is given herewith, in accordance with section 6, chapter 409, Acts of 1904, as amended by section 2, chapter 473, Acts of 1907.

Expenses incurred in Examination Work, charged to Owners.

Affleck, G. B.,	$5 22	Milford, town of,	–[1]
Bay State Street Railway Company,	2 80	Mixter, S. J.,	8 96
Bennett, Marion,	1 40	Mount Tom Golf Club,	4 77
Bird, C. S.,	–[1]	New Bedford water works,	4 00
Breague, Dr.,	1 50	Newburyport,	2 00
Brown, A. W. F.,	2 04	New Salem,	4 42
Brown, Wm. B.,	3 21	Norwell, town of,	–[1]
Bullard,	–[1]	Owen, G. W.,	1 00
Clark, H. W.,	1 04	Pabodie, W.,	80
Clinton water department,	1 83	Pearce, A. C.,	40
Crocker, C. T.,	2 28	Perkins, H. S.,	1 30
Cutting, Mattie B.,	50	Plumb, C. S.,	10 25
Dennison, H. S.,	1 10	Pousland, F. G.,	–
Fogg, H. T.,	1 20	Powell, E. C.,	4 01
Foxborough State Hospital,	–[1]	Reed, J. O.,	–[1]
Greenfield Woman's Club,	4 84	Ripley, A. L.,	1 04
Hale, R. W.,	75	Sibley, F. P.,	–[2]
Hardy, F. O.,	2 00	Stannard, Margaret,	1 04
Hellier, C. E.,	4 60	Stevens estate,	6 54
Holloway, G. W.,	80	Vesper Club,	1 30
Holliston school board,	1 60	Wakefield park board,	75
Hosmer, E. H.,	95	Washburn, C. G.,	2 00
Hunt, Daniel,	3 30	Watertown Arsenal,	–[1]
Hutchins, G.,	–[1]	Wharton, W. F.,	–[1]
Leland, P. F.,	3 00	White, A. P.,	90
Maynard & Edgerly,	94	Y. P. C. U. of Lynn,	–[1]
Metropolitan Water Board,	1 00		

Reforestation Work.

The reforestation work has been carried on this year along the same lines as formerly, and the increasing interest of lumbermen and landowners proves it a policy worthy of enlargement.

The plantations put in during the spring of 1909 and 1910 are showing up well, the growth in many instances on plantations made with transplant white pine being as much as 8 to 16 inches this last season. There was practically no loss this year from dry weather affecting these plantations, proving that when once well started they are not liable to be affected by climatic conditions.

Plantations made this year in one or two instances were quite badly affected by the exceedingly dry season, as might be expected.

Increased interest has been shown by parties looking over

[1] No expense.

[2] Transportation furnished.

A view from the lookout station for forest fires on Grace Mountain, in Warwick. Wachusett Mountain in the background, about thirty miles away.

A portion of the State Forester's nursery at Amherst. These are three-year-old white pine seedlings that will be set out permanently next spring.

plantations with the idea of making small plantings on their own land, and the large number of inquiries shows that this work is awakening great interest.

This year 860 acres have been planted, and deeds for 500 acres additional have been recorded which, from lack of sufficient appropriations, we were unable to plant. There are also now offered 700 acres more. The amount of work possible is governed entirely by the appropriation, and it would seem advisable for the State to enlarge this work.

Forest Nursery.

It has been impossible up to the present time to raise sufficient stock to take care of the planting done under the reforestation act, the department being forced to purchase a large number of seedlings from outside nurserymen at a much higher price than if raised on our own land. It has, therefore, been deemed advisable to enlarge our nursery from time to time, and we are now in a position to supply from our own nursery sufficient stock for our planting work next spring.

It being impossible to obtain land suitable for transplant work adjoining our present site at Amherst, it was deemed advisable to make this nursery the main one, raising seedlings and doing as much transplant work as the allotment of land would allow; to establish at Hopkinton a transplant nursery, and also to enlarge our nursery at Sandwich, where for the past two years we have been raising Scotch and Austrian pine, black locust and such varieties as are suitable for planting on Cape land.

Under this system we shall be able to ship direct from the nearest nursery to the planting site and in this way avoid much expense and delay in transportation.

The Amherst nursery has been in charge of our foreman, W. N. Tavener, the past season and was very capably managed. The exceedingly dry weather has not seemed to affect either last year's seedling or the transplant beds. This year's seedlings were affected, however, by the drought, though a fairly dense stand has been obtained. This year's transplants have made a remarkably good showing, and the work was much facilitated by the use of planting boards designed by one of the men at the nursery, this board enabling a man to put in a much larger number of trees and leave them firmer in the rows than when the old method was used.

At Hopkinton about an acre of land was ploughed up and made into transplant beds, and set with Norway spruce and white pine seedlings. This nursery has needed very little care except for two or three light weedings. It should be enlarged the coming spring.

At East Sandwich a good stand of Scotch pine was obtained, but the loss by drought of this year's seeding of white pine shows the inadvisability of trying to raise this variety from seed in that section, unless an irrigation system can be installed, which would be well worth the outlay both at the Sandwich nursery and at Amherst.

We shall have from these nurseries about 500,000 transplants and 350,000 three-year seedlings for field use this year, and with our two-year-old stock shall be able to take care of our entire planting work without purchasing elsewhere.

PLANTING DONE UNDER THE ADVICE OF THIS OFFICE.

NAME.	TOWN.	Variety.	Number of Trees.
F. C. Bent,	Sudbury,	White pine,	15,000
E. H. Brenan,	North Salem,	White pine,	1,000
H. S. Dennison,	South Framingham,	White pine,	5,000
T. M. Cole,	North Carver,	White pine,	3,000
F. C. Dunn,	Gardner,	White pine,	25,000
C. O. Flagg,	Gilbertville,	White pine,	5,000
Fitchburg Water Company,	Fitchburg,	White pine,	20,000
F. J. Tucker,	West Rutland,	White pine,	1,000
O. J. Stockwell,	Athol,	White pine,	3,000
B. D. Pierce,	Springfield,	White pine,	1,000
Island Park Box Company,	Bradford,	White pine,	1,000
L. C. Grosvenor,	Taunton,	White pine,	2,000
P. B. Hart,	Medway,	White pine,	6,000
C. W. Severance,	Bernardston,	White pine,	1,000
E. L. Sampson,	Plymouth,	White pine,	1,000
G. H. Simonde,	North Andover,	White pine,	1,000
Danvers State Hospital,	Danvers,	White pine,	2,000
R. B. Symington,	Plymouth,	White pine,	40,000
C. F. Choate,	Petersham,	White pine,	20,000
I. P. Lawrence,	Fitchburg,	White pine,	56,000
Miss C. B. Dobson,	Ipswich,	White pine,	1,500
Miss C. B. Dobson,	Ipswich,	Norway spruce,	500

PLANTING DONE UNDER THE ADVICE OF THIS OFFICE — *Con.*

Name.	Town.	Variety.	Number of Trees.
Lewis A. Wright,	Gardner,	White pine,	500
S. W. McCaslin,	Wellfleet,	White pine,	100
Town of Norwell,	Norwell,	White pine,	2,000
H. T. Fogg,	Norwell,	Miscellaneous,	7,000
Watertown Arsenal,	Watertown,	White pine,	2,000
Fall River water board,	Fall River,	White pine,	4,000

AMHERST NURSERY.

Variety.	Age (Years).	Number of Trees.
White pine seedlings,	1	2,000,000
White pine seedlings,	2	2,000,000
White pine seedlings,	3	450,000
Norway spruce seedlings,	1	500,000
Norway spruce seedlings,	2	1,000,000
White ash seedlings,	1	50,000
Catalpa speciosa seedlings,	2	500
Chestnut seedlings,	1	2,000
Maple seedlings,	2	500
Total,		6,003,000
White pine transplants,	4	250,000
White pine transplants,	3	325,000
Norway spruce transplants,	4	24,000
Red pine transplants,	3	14,942
Fir balsam transplants,	3	20,553
Hemlock transplants,	3	2,542
Arbor vitæ transplants,	3	6,634
Total,		643,671

HOPKINTON NURSERY.

Norway spruce transplants,	3	125,000
White pine transplants,	3	125,000
Total,		250,000

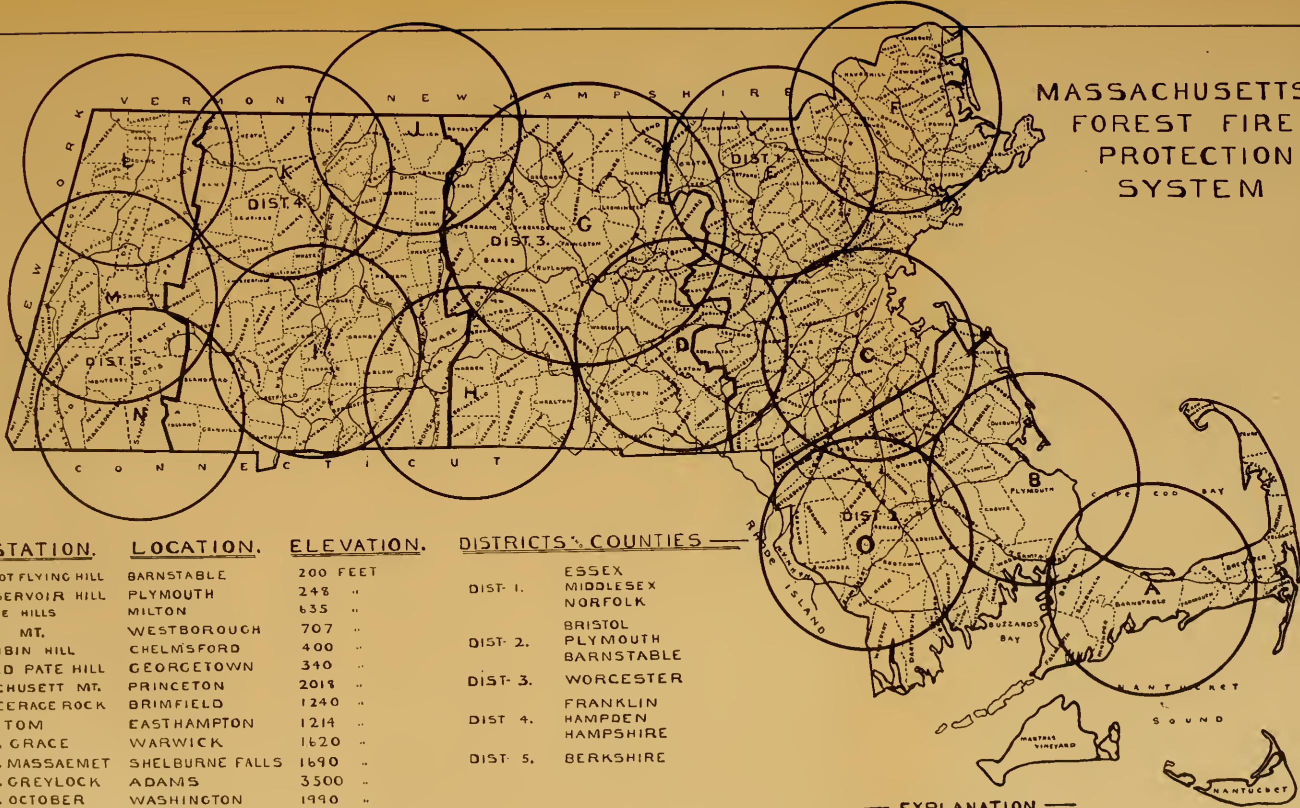
Sandwich Nursery.

Variety.	Age (Years).	Number of Trees.
Catalpa speciosa seedlings,	2	4,600
Black locust seedlings,	2	6,800
Black locust seedlings,	1	15,000
Honey locust seedlings,	2	5,000
Pitch pine seedlings,	1	30,000
Pitch pine seedlings,	2	100,000
Pitch pine seedlings,	3	130,000
Scotch pine seedlings,	1	30,000
Scotch pine seedlings,	2	100,000
Austrian pine seedlings,	1	20,000
Austrian pine seedlings,	3	1,000
Black locust transplants,	3	40,000
Total,	. . .	482,400

State Plantations, 1911.

Town.	Acres.	Type of Land.	Variety planted.
Ashburnham,	54	Cut-over land,	White pine.
Ashburnham,	94	Run-out pasture land,	Norway spruce, white pine.
Ashburnham,	14	Sprout land,	White pine.
Hubbardston,	40	Cut-over land,	White pine.
Hubbardston,	34	Cut-over land,	White pine.
Ashburnham,	63	Cut-over land,	Norway spruce, white pine.
Fitchburg,	27	Cut-over land,	White pine.
Paxton,	45	Cut-over land,	Norway spruce, white pine.
Shirley,	19½	Run-out pasture land,	White pine.
Kingston,	140	Burnt-over land,	Norway spruce, white pine, black locust, etc.
Lancaster,	74	Burnt-over land,	White pine.
Greenfield,	4	Open land,	White pine.
Lancaster,	8¼	Burnt-over land,	White pine.
Buckland,	166	Run-out pasture land,	White pine.
Buckland,	11½	Cut-over land,	White pine.
Attleborough,	21¼	Cut-over land,	White pine.
Yarmouth,	21	Burnt-over land,	White pine.
Harwich,	15	Burnt-over land,	White pine.
Sandwich,	10	Cut-over land,	Scotch pine.
	860½		

MASSACHUSETTS FOREST FIRE PROTECTION SYSTEM



STATION.	LOCATION.	ELEVATION.
⊖ A. SHOOT FLYING HILL	BARNSTABLE	200 FEET
⊕ B. RESERVOIR HILL	PLYMOUTH	248 "
⊕ C. BLUE HILLS	MILTON	635 "
⊕ D. FAY MT.	WESTBOROUGH	707 "
⊖ E. ROBBIN HILL	CHELMSFORD	400 "
⊘ F. BALD PATE HILL	GEORGETOWN	340 "
⊕ G. WACHUSETT MT.	PRINCETON	2018 "
⊕ H. STEERAGE ROCK	BRIMFIELD	1240 "
⊕ I. MT TOM	EASTHAMPTON	1214 "
⊕ J. MT. GRACE	WARWICK	1620 "
⊕ K. MT. MASSAEMET	SHELBURNE FALLS	1690 "
⊘ L. MT. GREYLOCK	ADAMS	3500 "
⊘ M. MT. OCTOBER	WASHINGTON	1990 "
⊘ N. TOWN HILL	SANDISFIELD	1760 "
⊘ O. RICHMOND HILL	DIGHTON	200 "

DISTRICTS & COUNTIES	
DIST. 1.	ESSEX MIDDLESEX NORFOLK
DIST. 2.	BRISTOL PLYMOUTH BARNSTABLE
DIST. 3.	WORCESTER
DIST. 4.	FRANKLIN HAMPDEN HAMPSHIRE
DIST. 5.	BERKSHIRE

— EXPLANATION —

⊕ - STATIONS IN OPERATION IN 1911.

⊖ STATIONS TO BE COMPLETED IN SPRING OF 1912.

⊘ STATION SITES PROPOSED.

REPORT OF THE STATE FIRE WARDEN.

Mr. F. W. RANE, *State Forester*.

SIR: — In compliance with your request for a brief outline of the forest fire organization and the work accomplished during my four months' administration of this branch of the department, together with a statement of the work done during the preceding months of this year, I beg to submit the following: —

By an act of the last Legislature $10,000 was appropriated for the prevention of forest fires. Under this act you were authorized to engage a State Fire Warden and necessary district forest wardens; also to adopt such other methods as would further protect the large area of timbered and forest lands within this Commonwealth.

The first work under this branch was the division of the State into five forest fire districts, each district being placed under the supervision of a competent district forest warden. The district arrangements are as follows: No. 1, Essex, Middlesex and Norfolk counties; No. 2, Bristol, Barnstable and Plymouth counties; No. 3, Worcester County; No. 4, Franklin, Hampden and Hampshire counties; No. 5, Berkshire County. The principal work of the district forest wardens has been in assisting in erecting telephone lines and observation stations, map making, visiting the selectmen and forest wardens in each town, and showing them the importance of appointing deputy forest wardens, and having them distributed advantageously in the outlying timbered districts of the town. The district forest wardens are to visit each town within their respective districts, and impress upon the selectmen and wardens the importance of purchasing forest fire equipment; also, in towns with a valuation of $1,500,000 or less, the necessity of taking advantage of the reimbursement act. A large number of towns coming under this act have already made application for the required blanks, and others, where funds are not available at the present time, will see that an article is placed in the warrant at the annual town meeting for the same.

Each district forest warden has under his personal supervision practically 1,000,000 acres, 70 per cent. of which is forest land. He has also supervision over three observation stations in his district covering this area.

We have established and have in operation 10 observation stations, each station covering practically 525,000 acres, or a radius of 15 miles. The length of time they have been in operation varies from two weeks to three months. As fast as completed they have been placed in operation.

District No. 1. — We have in this district two stations in operation, one of which is Blue Hill Observatory, Hyde Park, with an elevation of 635 feet, where we were able to secure the valuable services of the man already in charge. The use of the observatory has been tendered us without any compensation whatever, except the payment of the man in charge for the time actually employed on our work. This station was

placed in operation September 1 and discontinued November 10. This covers the Blue Hill Reservation and a large area of adjoining forest land in many towns.

We also have Robbin's Hill station in the town of Chelmsford, with an elevation of 400 feet, covering a large area of forest lands and protecting the watersheds of the Concord and Merrimac rivers. We were obliged to install telephone service here connecting with the New England Telephone Company at Chelmsford. We have also erected at this station a steel tower 40 feet high, with an observatory at the top. This station was placed in operation October 16 and discontinued November 10. In order to completely cover this district we are yet to establish a station in Essex County, in the vicinity of Bald Pate Mountain.

District No. 2. — In this district we have but one station in operation, Plymouth Observatory, which was placed at our disposal free of charge, we paying the observer for the time he is in charge of our work. This station covers a large tract of valuable forests, and was placed in operation September 11 and discontinued October 1.

We have also completed our telephone line on Shoot Flying Hill in Barnstable County, 200 feet elevation; but, owing to the rains and the lateness of the season, it was found unnecessary to place this in operation before spring. This station will cover a large portion of the Cape country. It will also be necessary to establish at least one more station in this district, and I think Richmond Hill in Dighton would be the most desirable selection, as it covers a large portion of Bristol County.

District No. 3. — We have in this district three stations in operation: Wachusett in Princeton, Fay in Westborough and Steerage Rock in Brimfield.

At Wachusett we were very fortunate in being allowed the free use of the observatory at the Summit House on Wachusett Mountain, with an elevation of 2,018 feet, and covering a radius of 20 miles, or an area of nearly 1,000,000 acres. From this station can be seen Boston harbor in the east and Greylock Mountain in the west. This station was the first to be placed in operation, August 14, and was discontinued November 10. Sixty-four fires have been observed and reported from this station alone. The watersheds of the Nashua, Miller, Chicopee, Thames and Blackstone rivers are protected by this station.

At Fay Mountain, with an elevation of 707 feet, we were obliged to install a telephone service connecting with the New England Telephone Company at Westborough. It will be necessary to erect a steel tower 40 feet high in order to completely cover the territory desired. The watershed of the Blackstone River and a large area of forest land are protected by this station, which was placed in operation October 8.

Steerage Rock, with an elevation of 1,240 feet, protects the watershed of the Connecticut and Thames rivers. At this station we were obliged to install a telephone service connecting with the New England Telephone Company at Brimfield. Arrangements have been made for

the erection of a 30-foot steel tower, with observation room at the top, from which this territory will be completely covered.

District No. 4. — In this district we have Mount Tom at Holyoke, Grace Mountain at Warwick and Massamet Mountain at Shelburne Falls. At Mount Tom we have also been extremely fortunate in being allowed the privilege of using the large observation room in the Summit House free of charge, where we have had at our command the use of 18 powerful telescopes. This station has an elevation of 1,214 feet and covers a large portion of Hampden and Hampshire counties, and also protects the watersheds of the Connecticut, Deerfield and Miller rivers.

Grace Mountain, with an elevation of 1,620 feet, protects the watersheds of the Connecticut, Deerfield and Miller rivers. At this station it was necessary to install a telephone system connecting with the New England Telephone Company at Warwick. We have also erected a 50-foot tower to completely cover the territory.

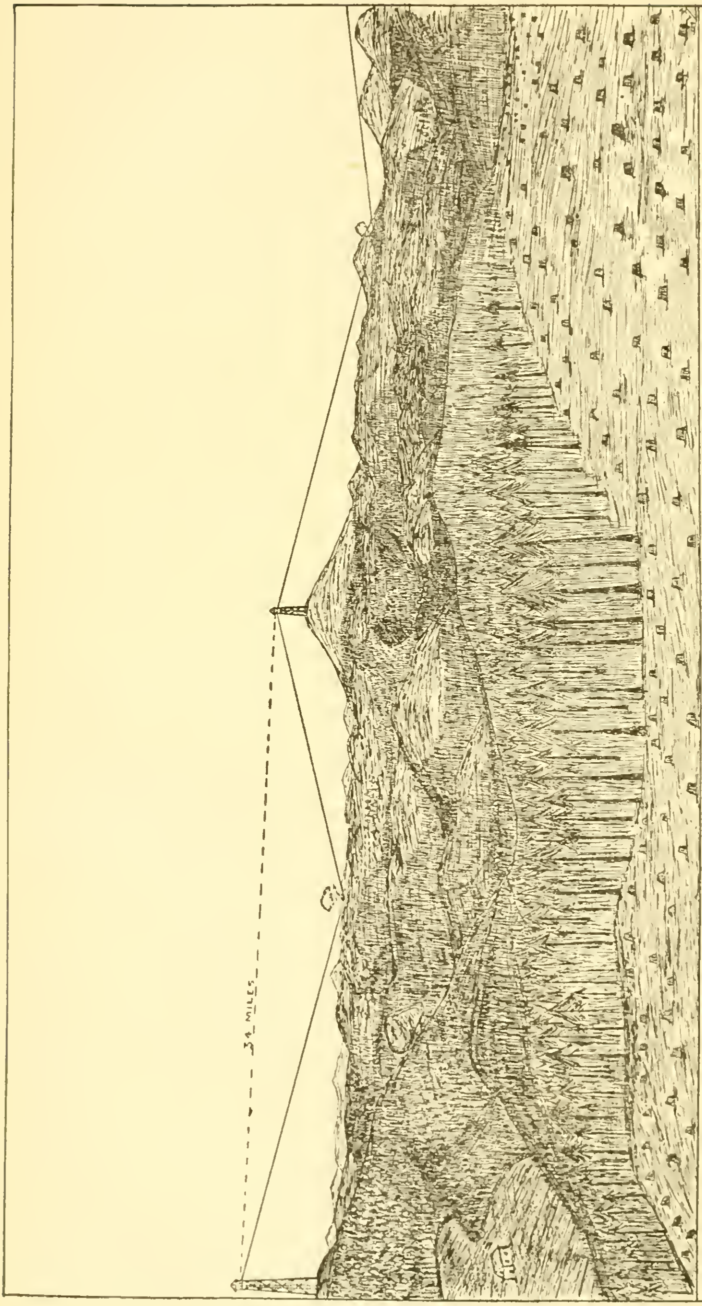
Massamet Mountain, with an elevation of 1,645 feet, covers a large portion of Franklin County and protects the watersheds of the Connecticut, Deerfield and Miller rivers. At this station we were donated the free use of the 63-foot stone tower, which completely covers the territory. It was necessary to install a telephone system on this mountain connecting with the Heath Telephone Company at Shelburne Falls. This station was placed in operation August 30 and was discontinued November 10.

District No. 5. — We have completed no permanent observation system in this district. An observer was placed on Greylock Mountain October 17, and his services were discontinued November 10. The principal reason for this was to determine the length of time this mountain was obscured by clouds. Owing to its elevation of 3,505 feet above sea level, the results were not perfectly satisfactory, but since it is a State reservation of 8,147 acres, and is already equipped with a telephone service and an iron tower 50 feet high, I feel that arrangements should be completed for the establishment of a permanent observation station at this point, to be placed in operation in the spring.

We have also had in view the advisability of establishing a station on October Mountain, but, owing to the delay in getting permission for the use of this mountain, it being a private preserve, we were unable to determine its value. We shall also establish a station in the southern part of Berkshire County, but nothing definite as to location has been arrived at as yet.

The above system, when completed, will cover practically every inch of the great Commonwealth of Massachusetts, from Cape Cod in the east to and including the Berkshire Hills in the west.

In explanation of our present system I wish to say that each observation station is in charge of a competent observer, a man thoroughly familiar with the territory surrounding his station. These men are equipped with powerful glasses and maps of their respective territory. They also have



SKETCH SHOWING METHOD OF LOCATING FOREST FIRES BY TRIANGULATION.

telephone communication with over 1,500 town forest wardens and deputy town forest wardens. In connection with the new maps now being made for the season of 1912 we are installing our new triangulation system, which will be used in extreme cases where the observer is not sure as to the exact location of a fire. This system is not in general use, as far as known, in any other section of the country, Massachusetts being the first State to adopt it for forest fire purposes. By this method fires can be located more quickly and much more accurately than would otherwise be possible. An explanation of the system is shown in cut on page 274.

The steel towers with which we are now equipping a number of the observation stations have an observation room 8 feet by 8 feet, with glass enclosure as far as possible, thus allowing our watchman to be continually on the lookout and also be thoroughly protected from inclement weather. Within these rooms are maps, telephone, report blanks, etc.; also a time clock, showing the exact time the observers are on duty.

Owing to the short period our stations have been in operation, and the amount of rainfall during this time, our reports show only 200 fires observed, none of which burned over 3 acres. What the outcome would have been had the stations not been in operation of course we do not know, but if we are to base an estimate on our experience in the past, it would be no exaggeration to say that thousands of acres of valuable timber were saved, owing to the fact that the lookout stations make it possible for the fires to be detected and extinguished in their incipient stage.

Forest Fire Equipment.

The Legislature in the spring of 1910 passed an act authorizing the State Treasurer to reimburse towns having a valuation of $1,500,000 or less 50 per cent. of whatever amount they might expend for forest fire equipment, providing this amount does not exceed $500, and providing, also, that the equipment purchased has the approval of the State Forester. As the law was not passed until after the annual town meetings of that year, but 16 towns availed themselves of the opportunity, and only $988.65 was expended, the amount expended by each town being very small during the year. The appropriation being continuous, the same amount was available again this year and 29 towns have taken advantage of the act, not only in purchasing small equipment, but several towns have practically used up their full allowance and purchased one of the wagons with full equipment. The amount expended this year to November 30, of which accounts have been received, is $3,917.32, thus showing a very marked increase over last year.

I might add that this department holds receipts from the different town forest wardens for the equipment purchased under this act. The equipment is also subject to inspection by the State Fire Warden or by a district forest warden at any time. The following table contains the names of the towns that have received reimbursement, the amount thereof, and the kind of equipment purchased: —

Towns receiving Fire-equipment Reimbursement.

Towns.	Amount of Reim-bursement.	Nature of Equipment.
Ashland,	$13 27	Pumps, pails and extinguishers.
Bedford,	220 92	One-horse wagon complete.
Belchertown,	71 62	Wagon and equipment.
Bolton,	58 40	Extinguishers, pails and shovels.
Boxford,	45 60	Extinguishers.
Carlisle,	193 72	One-horse wagon complete.
Charlton,	221 37	Extinguishers, pails and shovels.
Chatham,	146 53	Wagon and equipment.
Dighton,	58 67	Extinguishers.
Erving,	11 52	Shovels and hoes.
Georgetown,	55 33	Extinguishers, shovels and rakes.
Greenwich,	25 95	Extinguishers.
Groveland,	51 05	Extinguishers, shovels and rakes.
Hadley,	75 00	Extinguishers.
Hanson,	250 00	Wagon, extinguishers, shovels, rakes.
Holbrook,	45 00	Extinguishers.
Lunenburg,	149 28	Extinguishers and shovels.
Mashpee,	34 55	Extinguishers and shovels.
Middleton,	49 50	Extinguishers.
Newbury,	18 15	Extinguishers.
Northborough,	102 37	Extinguishers.
North Reading,	134 43	Wagon and equipment.
Norwell.	50 00	Extinguishers.
Oakham,	138 00	Extinguishers.
Pelham,	40 62	Extinguishers and pumps.
Pembroke,	203 75	Wagon and equipment.
Phillipston,	48 65	Extinguishers.
Plainville,	178 50	Extinguishers.
Prescott,	48 16	Extinguishers.
Princeton,	219 20	Extinguishers and cans.
Raynham,	50 00	Extinguishers.
Royalston,	22 35	Extinguishers, shovels and pails.
Sandwich,	245 60	Wagon and equipment.
Shutesbury,	87 50	Extinguishers.
Sterling,	231 75	Wagon and equipment.
Sudbury,	250 00	Extinguishers.

TOWNS RECEIVING FIRE-EQUIPMENT REIMBURSEMENT — *Concluded.*

Towns.	Amount of Reimbursement.	Nature of Equipment.
Tewksbury,	$174 00	Wagon and equipment.
Tyngsborough,	189 80	Pumps, extinguishers and shovels.
Upton,	133 53	Extinguishers.
Wendell,	35 07	Extinguishers, pails and shovels.
West Bridgewater,	200 12	Wagon and equipment.
Westminster,	55 91	Extinguishers, hoes, pails and shovels.
West Newbury,	33 75	Extinguishers.
Wilbraham,	136 31	Extinguishers.
Wilmington,	41 17	Extinguishers and shovels.

In this connection I wish to call your attention to our two sizes of model forest fire wagons. These were first constructed under the supervision of the State Forester in order that town officials might see what we consider an ideal form of apparatus. The larger wagon is intended for two horses, and costs, all equipped, about $450, the equipment consisting of 14 chemical extinguishers; 14 galvanized cans, each holding two extra charges of water and chemicals; shovels; rakes; mattocks; and spare chemical charges. This equipment is carried in racks and cases, not only so that it will ride safely, but also so that it may be conveniently carried into the woods. Eight men can find accommodation on this wagon.

The smaller wagon, drawn by one horse, has all the equipment of the larger, but less in amount. It will carry 4 men, and costs, all equipped, about $300.

The demand the past year having been so great, not only from Massachusetts but from adjoining States, several manufacturers are building forest fire wagons.

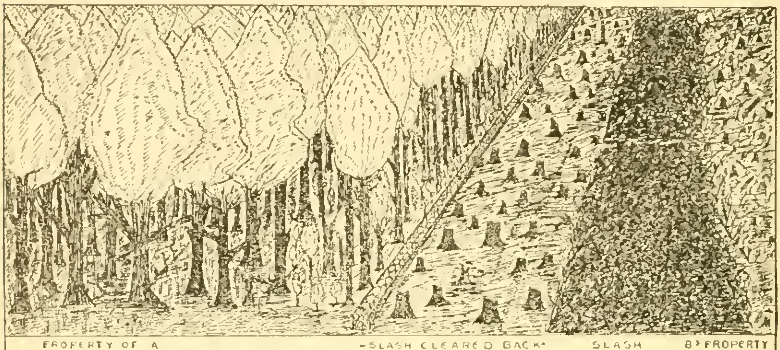
FIRE LINES.

A small part of the appropriation for fire work was used in the construction of fire lines, made primarily to protect some of the State plantations.

In Kingston this department had already commenced a fire line parallel to the Muddy Pond road at the westerly end of our plantation there, and this was continued for about a mile further to Muddy Pond. This road bisects the large area of burned-over country lying to the south of the town, and forms a very convenient place for fighting forest fires, so that this fire line is not only a protection to our plantation, but a great help to the town, which has agreed to keep the line in proper condition.

A fire line some 2,000 feet long was also constructed along one side of our plantation in Gardner, and a fire line surrounding a plantation in Templeton, which was made two years ago, was mowed over to clean up the brush that had grown up in the mean time. Altogether, about $450 was invested in this work.

These fire lines were all of the same pattern. First a strip about 50 feet in width is cleared of brush, which is piled and burned, and on the inside a



SKETCH SHEWING FIRE PROTECTIVE BELT BETWEEN STANDING TIMBER OF A & CUT OVER PROPERTY OF B.

ditch about 4 feet wide and 1 foot deep is dug. The theory is that the cleared portion will offer so little fuel for the fire that by the time it reaches the ditch it will be unable to cross.

Forest Fires of 1911.

It is with considerable reluctance that each year we include in our annual report a chapter on this painful subject, — painful, because forest fires are the greatest obstacle to the advancement of practical forestry throughout this Commonwealth. As long as this State continues to burn over from 35,000 to 100,000 acres each year, just so long will forest owners hesitate to make provision for natural reproduction, to plant trees, to make improvement thinnings, or to do other work looking to continued forest production.

The season just ended has undoubtedly been the worst fire season this State has experienced in many years. When we stop and compare figures with the records of the past three years we find that during 1908, 1909 and 1910 there was burned over throughout this State 116,976 acres, with a damage of $600,017, and in the year 1911 our reports show 99,693 acres burned over, with a damage of $537,749, nearly as much as the three previous years combined. Estimating the forest area of the State at 2,500,000 acres, which is a very conservative estimate (and in order to

reach this amount there has been included all the scrub growth and old pastures), it will require only twenty-five years to completely destroy every acre of forest land within this State. Then what is the result? Simply this: not only are we compelled to go elsewhere for our timber supply, but we have created a condition which seriously threatens our future water supply, for it has been demonstrated by the greatest engineers in the world that forests play an important role in the regulation of rivers. They retain for some time the rainfall and lessen the violence of flood flow. Whenever forests have been destroyed stream flow has always become more irregular and floods have increased in number and violence. Therefore, is it not time the public were awakened and a more thorough organization perfected to avert these dangers?

In order that this department might have a better understanding as to the conditions throughout the State, the district forest wardens have visited as many towns as possible, and have submitted a written report to this office as to the conditions in each town, the type of man the warden is, and the facilities the towns have for fighting forest fires. These reports show the two extremes. Many towns have been fortunate in obtaining the services of a man for the position of forest warden who has had wide experience and training in handling forest fires, and have equipped themselves with modern fire-fighting apparatus, while other towns have forest wardens who are indifferent with regard to their duties, and who have taken no measures whatever to provide proper fire-fighting equipment. Therefore it remains very necessary that mayors and selectmen use more precaution in selecting these men, and as fast as the ideal man who has the energy and courage to make a thorough and efficient forest warden is found, have the appointment a permanent one so far as possible. We also desire to urge upon mayors and selectmen the importance of equipping the forest wardens with modern forest fire-fighting apparatus. Again, forest fire laws will never be respected unless enforced. Examples must be made of those who violate them, so that others will be restrained from negligence in the use of fire.

Forest Fire Reports.

Town forest wardens undoubtedly do not appreciate the importance of making a complete report to this department of each fire as soon as it is extinguished. The system of fire reports has been in use but a very short period, and while the results along this line have been fairly satisfactory, the reports have been misleading and not absolutely correct. The two important points in fire protection are, first, preventive methods and education; and second, effective fire fighting. The only way this department has of knowing whether we are completely covering these points is by its system of reports. If the reports show that we are not covering these two points, then we are in a position to suggest a preventive method; but understand this is an impossibility unless we have these reports as soon as the fire is extinguished. For instance, take the railroad fire situa-

tion. The reports that have come to this office this fall show that we have had 685 fires from this source during the summer, and yet the department was unable to have an inspection of the locomotives made and the cause of the fires remedied, owing to the lack of reports at the time of the fire. This is a very essential feature, and we shall be obliged to insist that these reports be forwarded promptly.

In studying the tables of causes of forest fires for the past three years we note some very interesting data, as well as substantial improvement along different lines. The "unknown" cause has the largest percentage, it being 44.5. This is owing, in a great measure, to insufficient care being taken to ascertain the exact cause. This we shall endeavor to remedy to a large extent the coming season. Railroad fires show a reduction of practically 2 per cent. over 1910 and nearly 8 per cent. over 1909, which is certainly an improvement, taking into consideration the extremely dry season. "Burning brush" fires have been reduced from 16.2 per cent. in 1910 to 5.3 per cent. this year. This is, in a large measure, due to the permit law enacted during the last Legislature, which is giving general satisfaction and should be made uniform throughout the State. "Smokers, hunters and berry pickers" fires show a decided decrease over former years. The same is true of "Steam sawmills" and "Children" fires. "Miscellaneous" fires show an increase over 1910, but a decrease over 1909.

The table of forest fires for 1911 shows 2,536 fires, an increase of 1,151 fires over 1910, with the enormous damage of $537,749, burning over nearly 100,000 acres, with a cost to extinguish of $47,093. The most severe fires occurred in the months of April and May during the severe drought.

Comparative Damages by Forest Fires for the Past Three Years.

Months.	1909.		1910.		1911.	
	Acres.	Damage.	Acres.	Damage.	Acres.	Damage.
January,	13	-	-	-	140	$210
February,	12	-	-	-	7	25
March,	1,577	$4,763	12,666	$57,740	1,693	4,233
April,	12,515	72,195	13,782	68,867	29,213	138,120
May,	4,322	38,000	4,236	13,957	61,501	359,356
June,	405	11,870	137	980	622	3,638
July,	11,992	26,396	1,041	6,509	4,241	24,844
August,	1,940	10,833	165	1,275	2,226	7,204
September,	1,092	21,413	2,900	15,035	4	10
October,	384	1,805	7,068	40,064	10	32
November,	585	612	107	400	36	77
No date given,	246	1,515	114	556	-	-
Totals,	35,083	$189,482	42,221	$205,383	99,693	$537,749

COMPARATIVE CAUSES OF FOREST FIRES FOR THE PAST THREE YEARS.

Causes.	1909.		1910.		1911.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Unknown,	360	25.1	413	32.9	1,128	44.5
Railroad,	497	34.7	362	28.8	685	27.0
Burning brush,	149	10.4	203	16.2	135	5.3
Smokers, hunters, berry pickers,	140	9.7	124	9.9	158	6.2
Steam sawmills,	5	.5	1	.1	3	.1
Children,	92	6.4	75	5.9	118	4.7
Miscellaneous,	190	13.2	78	6.2	309	12.2
Too late for tabulation,	63	-	129	-	-	-
Totals,	1,496	100.0	1,385	100.0	2,536	100.0

FOREST FIRES OF 1911.

Months.	Acres.	Damage.	Cost to put out.	Number.
January,	140	$210	$50	29
February,	7	25	14	8
March,	1,693	4,233	859	191
April,	29,213	138,120	11,659	990
May,	61,501	359,356	24,337	837
June,	622	3,638	1,016	60
July,	4,241	24,844	6,388	205
August,	2,226	7,204	2,710	90
September,	4	10	21	4
October,	10	32	17	6
November,	37	77	22	7
December,	-	-	-	-
No date given,	-	-	-	109
Totals,	99,694	$537,749	$47,093	2,536

UNITED STATES GOVERNMENT AID.

The Weeks bill, so called, recently passed by Congress, providing for the purchase of portions of the White Mountain and Appalachian Mountain regions to be held as government reservations, also carried an appropriation of $200,000 for the protection against forest fires of the watersheds of navigable streams in the United States. One thousand eight hundred dollars of this appropriation was allotted to the State of Mas-

sachusetts to be expended in co-operative effort in such sections of the Commonwealth as would properly come within the provisions of the bill. This restricted our co-operative work to the western portion of the State, including the watersheds of the Nashua, Chicopee, Miller, Thames, Blackstone, Hudson, Connecticut and Deerfield rivers. As it was late in the season before final arrangements could be completed with the government, and as an unusually wet season prevailed, we were able to use only $360 of the allotment, allowing the balance to apply to the operations to be carried on in the year 1912. Under the terms of the agreement entered into with the United States government the State is required to expend an amount equal to that expended by the federal authorities in protecting the above-named territory.

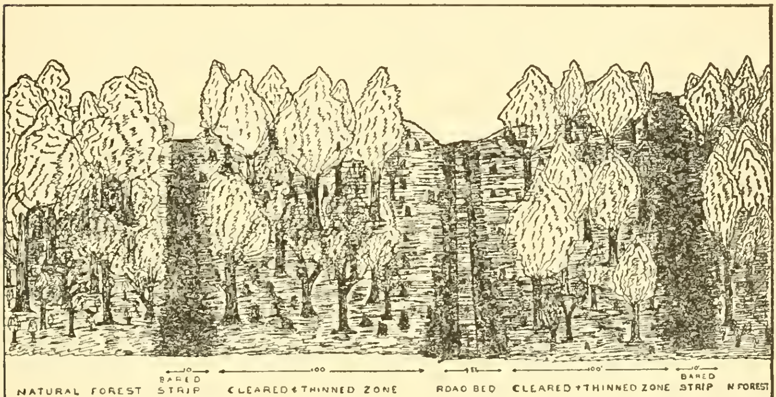
Railroad Co-operation in Forest Fire Fighting.

In tabulating our forest fire reports for the past season, while we find that the total number of fires from all causes is greatly in excess of former years, owing to the severe drought, the percentage of railroad fires is slightly reduced, although they still outnumber those of any other known cause. I sometimes think we are too hasty to criticize the railroads, not knowing the exact conditions they have to contend with; and unless one has made a study of railroad fires and preventive methods it is difficult to realize what it means to the railroads to completely eliminate railroad fires.

At this point allow me to say that the railroad fire proposition in this State is just in its infancy; therefore there is a chance for a great improvement. When we take into consideration that there are 2,110 miles of track and over 1,000 locomotives in use throughout the State it is not surprising that we must necessarily have a large number of forest fires from this source. Massachusetts is not the only State having this trouble, but practically every State throughout the west, where wood, coal or coke are used for fuel, is having the same experience.

Railroad officials throughout the country have been endeavoring for the past few years to construct a spark arrester, whereby railroad fires would be eliminated and also allow the free steaming of a locomotive. What is the result? Thousands of dollars have been spent on this alone, and still they are unable to meet the requirements. During the past season tests have been made on different railroads of new types of spark arresters or spark and cinder collectors, whereby the cinders are returned to the firebox and reburned, thereby saving a certain percentage in coal and practically eliminating railroad fires from this source. They are at present in the experimental stage, with the outlook very favorable that they will accomplish the desired results, and if this proves true, the railroads of the Commonwealth of Massachusetts will, without doubt, adopt them, thereby saving the many thousands of dollars they are annually paying out for fighting railroad fires and in settling railroad fire damages.

Owing to the above facts, it seems very necessary that the present railroad fire laws be more rigidly enforced. Section 1 of chapter 431, Acts of 1907, says: "Every corporation operating a steam railroad within the commonwealth shall, between the first day of April and the first day of December of each year, keep its right of way clear of dead leaves, dry grass," etc. I have made a personal inspection of several of the different branches of roads throughout the State, and find that this portion of the law has not been complied with. I find in many instances the grass and brush along the right of way has been cut but not burned or removed, which is very essential in order to prevent fires. The outcome is that we



RAILROAD FIRE LINE SKETCH.

have miles of railroad within the State with the right of way covered with dry grass and leaves, thereby causing immediate danger the first dry days in the spring.

It also seems to me that owners of timber lands adjoining the right of way are not using proper precaution to protect their property. It is a very easy matter, and one which entails very little expense, to clean out from the timber the underbrush and débris on a strip 75 feet in width next to the railroad right of way, thus mitigating the danger of fire very materially. Beyond this cleaned strip a regular fire line 10 feet wide should then be made by cutting the wood or timber, burning the brush, and keeping it as free as possible from grass and leaves. The cut on this page is an illustration of a modern fire line which will save property owners in this State many thousands of dollars if they will adopt it.

It is the contention among railroad officials that many railroad fires originate from cigar or cigarette stubs thrown from smoking-car windows. This is undoubtedly true in a great many instances, and there is no doubt that railroad fire claims have been paid that originated from this cause. The percentage of such fires we do not know. Allowing that 5

per cent. of these fires come from this cause, would it not be a good business proposition for the railroads in this Commonwealth to screen their smoking cars, thereby eliminating every railroad fire from this source? The expense would be nominal compared to the constant drain on them for fire losses. Reports made to this department show 685 railroad fires, burning over 29,842 acres, with a cost for extinguishing of $10,949.46 and a damage cost of $330,389.50.

Respectfully submitted,

M. C. Hutchins,

State Fire Warden.

Boston, Mass., Nov. 30, 1911.

The Chestnut Bark Disease (*Diaporthe parasitica*).

In my last annual report mention was made of the presence of the chestnut bark disease in this State, and that the State Forester had taken the matter up with Dr. Haven Metcalf, pathologist in charge of the Bureau of Plant Industry, United States Department of Agriculture, in order to determine, if possible, by cooperative effort, to what extent the disease exists in Massachusetts. Although it was known that the disease had caused irreparable damage to the chestnut growth of several States, notably New York, New Jersey, Pennsylvania and Connecticut, it was thought to have gained only a slight foothold in Massachusetts, but the report of Prof. Arthur H. Graves, the United States government expert, who, under the direction of the State Forester, made an investigation, shows that it is far more widespread and serious than was suspected by the most radical students of the disease.

The report of Mr. Graves is in part as follows: —

The chestnut bark blight has been found in 72 Massachusetts towns. The disease appears to be more general in the south-central and southwestern parts of the State. This is perhaps due to the fact that these portions are nearer to the badly infested regions in New York and Connecticut, and possibly also because on the whole more chestnut occurs here than in other parts of the State. In the southern part of Berkshire County the disease has already done a great deal of damage. There is every reason to believe that if the disease continues to spread as it has within the last half dozen years, it will ultimately cause tremendous havoc in Massachusetts, as it has already done in New York, New Jersey and Connecticut.

Supplementing the report of Professor Graves, Professor Metcalf writes the State Forester that "during the past summer the

disease has spread more than in all its previous history. Whatever is done in Massachusetts, as well as in every other State north of Virginia, must be done within the next year. Otherwise we definitely face the issue of the extinction of the chestnut tree. The methods of control already adopted in New York and Pennsylvania are the only practical methods that we know of controlling the disease. These methods are, briefly, the location and destruction of the small advance infection beginning in that part of the State farthest away from the center of infection. We cannot too strongly advise the eradication as soon as possible of all advance infection of this disease in Massachusetts, beginning in the eastern part of the State. It is probably already too late to save the southwestern part of the State by any method."

The State Forester is anxious to give to the public all the information obtainable relative to this disease, such as the above reports. He believes that valuable tracts of chestnut properly handled along forestry lines may be protected from serious injury, and he will be pleased to advise owners of such properties the best protective measures to employ. A bulletin recently issued by him treating of the disease and its remedy, with illustrations, will be mailed upon request to citizens of Massachusetts. Another bulletin discussing the entire situation, giving the method of control in detail and the status of the disease in the United States as a whole, may be obtained by applying to the United States Department of Agriculture, Washington, D. C.

List of Massachusetts Towns (by Counties) in which the Chestnut Bark Disease has been found.

Berkshire County.

Alford, 2 or 3 per cent.
Egremont.
Great Barrington, 50 per cent. in spots.
Hancock, scattering.
Lee, 50 or 60 per cent. in spots.
Lenox, 10 per cent.
Monterey, scattering.
Mount Washington, 50 per cent. or more.
New Marlborough, general infection.
North Adams, scattering.
Richmond, scattering.
Sheffield, 5 or 10 per cent. in spots.
Stockbridge, general infection.
Tyringham, one tree found.
West Stockbridge, general.
Williamstown, a few trees.

Franklin County.

Buckland, scattering.
Charlemont, a few trees.
Deerfield, 10 or 20 per cent.
Erving, a few trees.
Gill, one tract found diseased.
Shelburne, scattering.
Sunderland, 50 per cent.
Whately, 30 or 40 per cent.

Hampshire County.

Amherst, general.
Belchertown, scattering.
Easthampton, scattering.
Granby, scattering.
Hadley, very bad, 50 per cent. or more.
Hatfield, general.
Huntington, general.
Northampton, general.
Pelham, scattering.
South Hadley, scattering.

Hampden County.

Brimfield, scattering.
Chester, general.
Chicopee, general.
Holyoke, general.
Longmeadow, general.
Montgomery, general.
Palmer, scattering.
Russell, general.
Springfield, general.
Westfield, general.
West Springfield, general.
Wilbraham, general.

Worcester County.

Athol, general.
Auburn, scattering.
Barre, scattering.
Dana, scattering.
Dudley, scattering.
Grafton, scattering.
Harvard, scattering.
Hardwick, 12 trees.
Leicester, three trees seen.
Millbury, scattering.
New Salem, four trees.
Northbridge, scattering.
Petersham, general.
Shrewsbury, general.
Southborough, one tree found.
Sutton, scattering.
Uxbridge.

Middlesex County.

Bedford, one tree.
Framingham, a few trees found.
Marlborough, one or two trees found.
Wayland, a few trees found.

Norfolk County.

Canton, two trees found.
Dedham, one tree found.
Norwood, several trees found.
Sharon, several trees found.

Bristol County.

Attleborough, scattering.

Proposed Cure for the Lumbering Slash Evil.

The sketch on page 278 represents the State Forester's idea for lessening the danger of forest fires starting in slash. He believes that a property owner has no right to endanger the property of a neighbor by leaving a lot of dried and easily inflammable slash bordering on or even encroaching on the other's woodland. To compel an owner, however, to burn his entire slash after a lumbering operation is an expensive and often needless operation. Sufficient protection can be had by dragging back all the dead limbs and tops for a

space of 40 or 75 feet, and leaving it there until it can be burned safely.

This was done by this department in one instance, a strip 60 feet wide and 100 rods long being cleared at an expense of $40. This work was done after the slash had been lying on the ground for two years and had become well matted down and consequently hard to handle. Had it been done while the logging was going on the expense would have been comparatively small, because it is necessary to handle the slash over more or less in the work of logging, and the additional work necessary to clear a strip as described is not great. (See illustration on page 278.) Legislation was introduced by the State Forester last year looking to a regulation of this kind, but it was not reported by the committee.

Lectures and Addresses.

The demand upon the State Forester for engagements in the State and abroad have been very great, and he has been compelled to send assistants to take his place at times. The usual custom of last year to make the meetings open to the public and ask for a guarantee of an audience of one hundred or more has proved very satisfactory.

The usual lectures were given at the Massachusetts Agricultural College during the winter.

The following organizations, clubs and associations were addressed during the year: —

Massachusetts State Board of Agriculture, Winter Meeting.
Boston Y. M. C. A.
Boston Lumbermen's Association.
American Forestry Association.
Cape Ann Scientific and Literary Society.
Boston City Club.
Chamber of Commerce, Boston.
Springfield High School of Commerce.
Massachusetts Agricultural College.
Boston High School of Commerce.
Massachusetts Retail Lumbermen's Association.
Middleborough Cabot Club.
Newton Highlands, Episcopal Men's Club.
Union Club, Governor Rollins.
Tyngsborough Village Improvement Association.
International Paper Company, New York.
New England Water Works Association.
Melrose Woman's Club.
Taunton Men's Club.
Milford Woman's Club.
Revere Woman's Club.
Sharon Fortnightly Club.
Massachusetts Forestry Association.
Athol Men's Club.
Ohio State University Club.
Massachusetts Agricultural Club.
Norwood Business Men's Association.
Society for the Promotion of Agricultural Science.
Waltham Baptist Men's Club.
North Andover Village Improvement Association.
Boston Wholesale Lumbermen.

Fitchburg Board of Trade.
Brewster Grange.
The Rural Club.
Weston Boys' School.
Pepperell State Grange Field Day.
Eastern Forester's Association.
Dudley State Grange Field Day.
Dracut State Grange Field Day.
Randolph Woman's Club.
Third National Conservation Congress.
Townsend Board of Trade.
Nantucket Teachers' Association.
Swampscott Woman's Club.
Shirley Improvement Association.
Greenfield Woman's Club.
Association of American Colleges and Experiment Stations.
Mansfield Men's Club.
Old Boston Dining Club.
Massachusetts Forestry Association.
Lumber Salesmen's Club.
Grange, Turner Center, Maine.
Foxborough Board of Trade.
Springfield Board of Trade.
Lenox Horticultural Society.
Massachusetts State Board of Agriculture, Annual Meeting.
Weymouth Grange.
Worcester Central Pomona Grange.
Massachusetts Firemen's Association.
Lexington Men's Club.
Plymouth Natural History Society.
Scituate Men's Club.
Wilmington Men's Club.
Woburn Grange.
Worthington Grange.
Massachusetts State Y. M. C. A.
Cohasset Men's Club.

The Third National Conservation Congress met at Kansas City, Mo., September 25 to 27, and the State Forester was appointed a delegate by Governor Foss.

The congress proved a very interesting and instructive one. The following paper was presented by the State Forester: —

Conservation, Restoration and Economic Utilization of Massachusetts Natural Resources.

In complying with the request of the officials of this association in reporting herewith for the State of Massachusetts, I wish to say at the outset that I certainly feel incompetent to undertake the task of pointing out the numerous activities that the good old Bay State is fostering. Being a Massachusetts citizen by adoption, I feel privileged to express myself the more frankly, as otherwise my report might seem prejudiced.

We have in Massachusetts in the first place a conservation of the old-time ancestry which is not only renowned for its brillant deeds in the nation's early history, but is still firm and abiding even after these many years. What state has a fairer reputation in its dissemination of its natural resources, and still lives to enter more heartily into the conservation and restoration of those remaining?

The historic setting and general environment of Massachusetts in the early days of the nation are natural resources that constitute an ever-bubbling fountain. Yearly the pilgrimage to the old Bay State of thousands upon thousands from throughout the nation, to visit Boston, Concord, Lexington, Arlington, Cambridge, Salem, Plymouth and a score of other cities and towns, goes to show what the conservation of high ideals and true patriotism means.

The State has always been liberal, progressive and a natural leader in all that stands for education, advancement and enlightenment. Many wonder at the splendid showing that Massachusetts always makes, and seem confounded at her successful progress. The explanation is that as a State we do not confine our interests to State bounds, but our people are equally interested in promoting and developing copper and other mines, or sheep ranches and other industries, in the south or west, as much as they are at home. Succeeding elsewhere means also better opportunities for home development. In this way mutual associations and enterprises of a stalwart and permanent nature are established.

The old biblical saying that it is more blessed to give than to receive is literally true of the old Bay State. While she has been generous in the nation's life, yet there are few States that for their size have greater natural advantages and hold out better prospects for success in the future.

Contrary to the minds of many, Massachusetts has advantages that are hard to surpass. I wonder how many have read the article entitled "Golden New England," by Sylvester Baxter, which appeared in the "Outlook" in 1910. If not, you may be interested in doing so. The author therein portrays various rural industries and very entertainingly points out their success. One of our enterprising business houses, N. W. Harris & Co., bankers, Boston, very kindly has sent out excerpts to those desiring the same.

Massachusetts is a State with many manufacturing centers, and therefore a great consumer of all kinds of resources, particularly in the raw material. This material is put through our factories and goes out as the manufactured article.

Our high standard of education in literature, science and art has evolved men of usefulness. In the modern or applied sciences we point with pride to our technical, agricultural and trade schools, which are already accomplishing results toward conservation, restoration and economic utilization of natural resources.

Massachusetts people began to see the handwriting on the wall many years ago, and even before this congress was born they were agitating and accomplishing actual results. Our cities and towns are already well forearmed with generous water supplies. The great metropolitan water system of Boston and its suburbs, already a reality, is one of the greatest engineering feats yet accomplished in its line. Our metropolitan and municipal park systems are a credit to our people. The State highway system of Massachusetts needs no introduction to an intelligent audience like this, as its reputation has attracted road engineers from all over the world, and many States have come to the Massachusetts Highway Commission and induced our men to go away. Dr. Field of the Fish and Game Commission is here at the convention; hence he will inform you of this field of our activity. Simply let me say that our marine natural resources are far greater than most people realize. Massachusetts has a large and important coastal boundary, and were I able to tell you of the great

possible future we have in mind, even for the old historic Cape Cod country, I know it would interest you. While the great fishing industries of old Gloucester, Nantucket and New Bedford are not as thriving as in earlier times, nevertheless, with the guidance of modern science to water farming, we have great promise of the restoration of these industries that will go far toward feeding the nation in the future.

Speaking of fishing and game, forestry, natural history and Appalachian clubs, I am frank to say that I believe there are no people on earth who are more in love with nature herself, heart and soul, than our Massachusetts people. We have organizations galore, and they are not only organized, but bubbling full of real activity, and are accomplishing things. Were you the State Forester of Massachusetts, I can guarantee that you could spend your whole time simply lecturing on conservation or forestry, as the demands are so great and the work so popular.

Insect Depredations.

In the development of a new nation it invariably follows that conditions are constantly changing, and as intercourse with other nations progresses, through trade and business relations, the evils and blessings are shared. While we are greatly indebted to the various countries of the world for many an introduction, nevertheless now and then we unfortunately get an insect, or fungous development, which proves extremely disastrous.

It would not be fair to Massachusetts in reporting on her conservation policies did I not mention the great fight that the State has waged for years against the gypsy and brown-tail moths. These two insects are indigenous to Europe, and while they have their natural enemies and are under subjection there, upon reaching this country they find an open field, and, with no enemies, become a veritable pest.

Both species are destroyers of trees. The brown-tail moth devours the leaves of the deciduous or hardwood trees only, while the gypsy moth is no respecter of vegetation, and will defoliate evergreens as well, if food is scarce, although it, too, prefers the deciduous trees. The brown-tail moths, besides being tree destroyers, give off hairs from the larva and moth which, when brought in contact with the skin of human beings, produce a rash that is extremely irritating. Of the two insects the gypsy moth is generally considered the worse. The facts that when the white pine or other evergreens are once stripped they die outright, and that the pine in particular is one of our most valuable species, both from the economic and æsthetic standpoint, make their protection from the gypsy moth important.

I will not take time to give you the life histories of these insects, for should any one be interested this information can be had by applying to the State Forester, Boston, Mass. We have illustrated matter in natural colors, showing these insects.

Practically all of our trees in the residential sections of cities and towns in the eastern part of the State are sprayed annually. Our main traveled

roadsides are sprayed each year. Individuals, the municipalities, towns and the State all co-operate in this work. The annual appropriation of the State is $315,000 a year. The total expenditure from all sources in this work within the State up to the present time is estimated at $6,000,000. Besides this, the United States government has spent in Massachusetts probably $700,000. We have had as many as 2,700 men at work at one time in the busiest season of the year. The renowned North Shore, our fashionable summer resort, spends practically $100,000 a year to protect the trees in that section alone.

The State Forester's spraying apparatus is composed of an aggregation of 300 spraying outfits. We use in a single season over 400 tons of arsenate of lead, the State's contract alone being for 250 tons a year.

During the past two years the State Forester's department has made great improvements in power-spraying equipment, the cost of spraying woodland having been reduced from $30 or more per acre to as low as $6 in some instances. Instead of its being necessary to climb trees, as heretofore, the modern power sprayer enables us to spray from the ground directly over the tops of tall trees. The whole spraying problem has been revolutionized. It is certainly to be hoped that these insects may not secure a foothold elsewhere. Surely Massachusetts is doing her part, and I cannot urge too strongly the necessity of other States and the nation realizing the importance of this work. We have introduced parasites from all over the world, and they are showing great promise. The work with disease also seems very effective, and the writer feels optimistic. It is very clear that the practice of modern forestry methods and the employment of highly developed mechanical devices are doing much, and we trust ere long the parasites and diseases will bring about the desired result.

Forestry.

Massachusetts is enthusiastically interested in forestry, and the State Forester this past season was given an appropriation of $10,000 for forest fire work. We have appointed a State Forest Fire Warden, who is organizing and perfecting a workable system. He is also establishing lookout stations and patrol systems in different sections of the State.

Our forest management, reforestation and general forestry, educational and demonstration work are all well established and progressing. We have 3,000,000 trees in the State nursery for use another season. The State is planting 1,000 acres each year, and our lumbermen and people generally are showing interest, and doing more each season. Our appropriation, including that for forest fires this past year, was $30,000.

Restoration v. Conservation of Natural Resources.

In Massachusetts the work of restoration is even of more importance than conservation when applied to forestry. The annual cut of our forest products at present amounts to only 5 per cent. of that used each year throughout the Commonwealth for manufacturing, building and

other purposes. Surely we can and ought to supply a larger amount of our own home-grown woods. Although the State has been well cut over, even now our present wood harvests play an important factor in the industries of many of our rural sections. While we believe thoroughly in conservation where it will apply, still the more potent force begins further back. We need to teach the A B C of restoration in forestry. When our work of reforestation shall have begun to demonstrate its value, it will be an object lesson which will mean much toward perfecting a better State forest policy.

Practical forest restoration, therefore, is what Massachusetts needs most. If we will reconvert our hilly, rocky, mountainous, moist, sandy and waste nonagricultural lands generally into productive forests, the future financial success from rural sections of the Commonwealth is assured. This is no idle dream; it can be accomplished. Massachusetts is a natural forest country and all that is needed is simply to assist nature, stop forest fires and formulate constructive policies. Then we can grow as fine forests as can be found anywhere. Germany and many of the countries of the old world have already demonstrated what can be done. Are we to be less thrifty and farsighted? Americans do things when they are once aroused, and it is believed that reforestation and the adopting of modern forestry management must be given due consideration in this State from now on.

The writer has been delighted in following the interest that has been aroused and the great tendency for all our people to not only welcome and appreciate the new idea of "conservation," but to even credit the term or phrase as covering every phase of new endeavor.

It is not my purpose to lessen the glory one whit or bedim a single gem in the crown of the national phrase "Conservation of natural resources," nor could I were it to be tried, for the heralded motto has already stamped itself firmly upon the nation.

As time goes on, however, it will be found that our popular phrase will not carry with it the whole panacea of overcoming our wasteful and depleting conditions, and that new and equally applicable terms, though perhaps never so popular, will come to express more aptly our real needs.

To my mind the phrase "Restoration of natural resources" vies with that of "Conservation of natural resources," and expresses a force to be aroused in the nation for good that in many ways surpasses the present popular one.

We have our forest reserves and minerals that are left, and now to conserve them economically is a worthy undertaking; but in the older sections of the nation to conserve what we have in depleted and worn-out lands and forests is to pick the bones of the withered and shrunken carcass.

Let conservation apply where it may, but the force that is needed in Massachusetts and all of New England, yea, the south, extending even well into the middle of the nation, following the great depleting agri-

cultural cereal and cotton crops on the one hand, and the lumberman's axe and forest fires on the other, is greater than this term can begin to express.

The term "Restoration of natural resources," I claim, meets our present needs far better, and breathes greater hope and definite accomplishments for our children's children in the future.

The following paper by F. W. Rane, State Forester of Massachusetts, was read before the New England Water Works Association, March 8, 1911: —

THE REFORESTATION OF WATERSHEDS FOR DOMESTIC SUPPLIES.

Mr. President and Gentlemen of the New England Water Works Association: — The subject of municipal forests is more or less of a new idea, but I can see where forestry and water works are naturally coming together more and more. Most of you gentlemen, I take it, are engineers. Now, how can forestry come in along with your lines of work? I think the subject is likely to be of more and more importance, as time goes on, to water-works people. I take it for granted that a great many of the works represented here are municipal works. Some of them may be private corporations, but they are all run upon practically the same lines. A few years ago, in 1908 I think it was, we had occasion in the State Forestry office to work out a plan for the city of Fall River, covering about 3,000 acres. At that time the mayor and the commissioners and the engineer had an idea that they were going to carry the plan into effect, but for some reason or other it unfortunately has not been carried out to the extent that they had hoped it would be. They are doing something, however. They have an area of about 3,000 acres surrounding their water supply, and if any of you are interested in the report we made, I have extra copies at the office and would be glad to send them to you upon application.

At that time I read a paper before one of our scientific societies, the subject of which was "Municipal, Corporation and Private Ownership Forests," and, with your permission, I will read you a few paragraphs from that paper bearing particularly upon the subject of municipal forests: —

The time is ripe for the development of this type of forestry. I believe all that is required at present is to agitate the subject and to explain how easily and economically it can be brought about. Our cities and towns have sprung up by the hundreds and thousands throughout the land. Their development has been proportionate to their natural advantages. Permanency has become more stable as time has gone on, until to-day finds us with municipalities ready and willing to accept and adopt almost any measure that will develop a better future and a busier center of population. Our cities and towns have been solving the problems of a permanent and efficient water supply, sewerage system, etc. Our boards of health tell us that a pure water supply is absolutely necessary to longevity of our population. Municipal forests about the drainage basins of our water supplies and reservoirs can be made not only an important factor in conserving the

water supply and in improving sanitary conditions, but, if put under a modern system of forestry management, could be made a great economic factor in the production of wood and lumber. They may also comprise one of the great æsthetic features of the section. The time element as a factor, so objectionable to the private owner in investing in forestry undertakings, need not be considered here. The advent of the automobile and rapid transit has so enlarged the conceptions of the average citizen that instead of being content with shade trees and park systems he longs for the depth and quiet of large tracts of woods, which may be furnished almost without cost through the wise forethought of our municipalities. Who has visited Germany without being impressed with the trip into the Black Forest? These very forests are not only beautiful and renowned, but through their scientific treatment yield splendid net financial returns. Within walking distance from many of the cities, one can step into finer woods than can be found in our best eastern States. Spruce and fir trees 2 to 3 feet through and all the way up to 125 feet high stand on the ground as thickly as they can stand. There are acres that would cut more than 100,000 feet board measure.

Municipal forests, therefore, will do much as object lessons, and their permanency and importance will assist very materially in forming a workable local, State and national policy.

The State Forester of Massachusetts has completed a working plan for the city of Fall River this season for a municipal forest of 3,000 acres. We are working on similar projects for three more cities at present, with still others on the waiting list. The Metropolitan Water and Sewerage Board of Boston have completed planting 1,100 acres to forest trees about their new reservoir this fall. The city of Helena, Mont., has planted a forest of 900 acres. Warren Manning, the noted landscape gardener, the designer of the Jamestown Exposition grounds, etc., is an enthusiastic advocate of the broader forestry municipal development, as going hand in hand with landscape gardening.

In a State like Massachusetts, where many park reservations like Mount Tom, Wachusett, Greylock, Blue Hills, metropolitan park system, Mount Everett, etc., have already been set aside for public purposes, if to these park systems, municipal parks and forests be added as well as corporation and private forests, together with increased holdings for fish and game preserves, it is evident that conditions will be developed which will make our State greatly to be envied. What has been and may be accomplished in Massachusetts can be wrought with equal ease throughout the Union to a greater or less degree.

Considering an imperative necessity for the growing of our future forest products, and considering the opportunity for business corporations and men to not only secure financial gain but bring great good to their respective communities, there certainly will be need in the future for all our well-directed acts of the present day. Is it not exceedingly fortunate that the conditions outlined do exist, and that the solving of them offers hopes to the future? It is fortunate, too, that as a people we are ever ready and quick to respond to any undertaking, no matter how strenuous the task, provided it will secure us benefit and reward. I have every hope, therefore, that our forestry problem will receive an early consideration at the hands of our people, and that all sections of the Union will do their respective parts in conserving the forests we already have and adopting modern methods of forest management, as well as in reforesting lands unadapted to agriculture, returning them to forests, for which to all intent and purposes they were created.

There has been of late much discussion on the subject of forests and their relation to stream flow, and we could, if we chose, give you a sermon on this subject, but we have elected in this article to present to you the financial side of the question; in other words, the money profit which

towns may obtain from lands which are now in their possession lying idle and unused. We believe that the time is not far distant when municipalities, like the State and nation, will take up forestry development in their midst, and that our towns and cities, like the communities of the Old World, will own their municipal forests. On the land which they have already acquired for the protection of a water supply is the place to begin.

Appended is given a list of 47 towns holding such lands, and the area held. Ten of these have sought advice from this office in regard to the management of their lands, and 8 have in part carried out our suggestions, yet we are compelled to say that even these are only playing at forestry work.

No one is in a more fortunate position to practice forestry than a municipal water commission. It has as a rule no taxes to pay, the time element so detrimental to private ownership is wanting, because a municipality has, in theory at least, an everlasting existence, and the land which was bought as a protection for the water supply, from the forestry standpoint costs them nothing.

The Metropolitan Water Board has planted some 1,200 acres of land with pine and hardwoods at an average cost of $20 per acre. In addition, in the first ten years they have had to spend $6 per acre for improvement cutting, and about 25 cents per year for fire patrol. The studies of this office have shown that average land planted to pine will yield 46,500 feet per acre in fifty years, worth on the stump at present prices $465. Now let us balance these figures, figuring our investment at 3½ per cent., a fair average rate of interest on most municipal bonds.

		Stumpage Yield per Acre.
Cost of planting at $20 for fifty years, interest 3½ per cent. compounded,	$111 70	$465 00
Improvement cuttings at $6 for forty years, interest compounded at 3½ per cent.,	23 75	
Fire patrol 25 cents per year for fifty years, interest compounded at 3½ per cent.,	33 90	
Add to make even dollars,	65	
	$170 00	$465 00

This leaves a net balance of $290 profit per acre over and above 3½ per cent. return on the money invested, a rate of return equal to 7½ per cent., and this is based on stumpage prices prevailing at the present time, and stumpage will certainly be worth no less fifty years hence. Will you not agree with us that a town that holds land which is lying waste and idle, owned merely to keep some one from living on it, is committing a grave economic mistake when it fails to develop it into a forest?

To take a practical example of the value that forestry can be to a town, Westfield owns 942 acres of land on its watershed in Granville, of which this office made a careful study. We found that 488 acres of this area were covered with some form of woodland and 454 acres were more or less

cleared, 315 of which could be planted. We made our estimate of the income which may be derived from this land, giving its value at the time of cutting, basing the amount on present stumpage values.

Types of Land.	Area (Acres).	Stumpage Value.	Ready to cut.
Large hardwoods,	33	$2,640 00	Present.
Large pine,	4	800 00	Present.
Medium hardwoods,	36	3,000 00	10 years.
Medium pine,	4½	900 00	12 years.
Medium pine and hardwoods,	21	1,500 00	10 years.
Culled land,	160	15,000 00	25 years.
Small hardwoods,	104	8,000 00	18 years.
Pine planted,	315	108,000 00	50 years.

These figures when added show a net income to the town during the coming fifty years of approximately $140,000. To arrive at the net income on the planted land we have deducted $6,300 as cost of planting, $1,890 for improvement cuttings, $3,780 for fire patrol and $26,500 for taxes on the planted land. Taxes on the woodland (it being located in another town) would have to be paid whether forestry work was carried on or not, so they were not deducted in estimating the returns on the forested land.

We cannot, in the narrow limits of this article, give the processes by which we arrived at the above conclusions, but we ask you to take them on faith, assuring you that we have done our best to be conservative in our estimates, basing them, as we said before, on the present values of lumber land.

This office has given suggestions to 10 municipalities that have asked for our advice, and these suggestions have been embodied in written reports, in some cases in great detail. We stand ready to help any community in the State, the extent to which we will offer our services depending a great deal on how far the town will go in carrying out our suggestions after they have been made. The only cost to the town is for the traveling expenses of the man or men who make the examination and report. Most of the other States in New England have forestry officers who will give the same service, and where they cannot be secured there are firms of consulting foresters who can be called upon to give advice without excessive cost.

Municipal Water Supply Lands.

List of Cities and Towns which have sought Advice from the State Forester concerning Forest Management of Such Lands, and Record of Accomplishments to Date. All since Fall River Report of 1909.

City or Town.	Ownership, Municipal or Private Company.	Watershed Owned (Acres).	Existing Woodland (Acres).	Planting accomplished (Acres).	Plantable Area remaining (Acres).
1. Fall River,	City,	2,940.6	2,507	5	433
2. Westfield,	Town,	942.0	488	20	454
3. Holyoke,	City,	2,200.0	1,400	12	800
4. Leominster,	Town,	94.7	(?)	12	None.
5. Fitchburg,	City,	400.0	250	None.	150
6. Amherst,	Company,	131.0	(?)	35	(?)
7. Needham,	Town,	91.6	50	5	35
8. Hudson,	Town,	162.0	(?)	18	(?)
9. Milford,	Company,	36.0	16	None.	20
10. Pittsfield,	City,	1,123.0	723	None.	400

Tentative List of 37 Cities and Towns having Water Supply Lands possibly capable of Foresting. Twenty-Five Acres and Over.

[Project as yet unconsidered. Areas from State Board of Health.]

City or Town.	How owned.	Watershed (Acres).
1. Adams,	Fire district,	33.5
2. Athol,	Town,	301.0
3. Attleborough,	Town,	300.0
4. Barre,	Company,	35.0
5. Billerica,	Town,	25.8
6. Brockton,	City,	225.0
7. Clinton,	Town,	197.5
8. Falmouth,	Town,	82.1
9. Foxborough,	District,	26.0
10. Hatfield,	Town,	40.0
11. Haverhill,	City,	668.0
12. Lenox,	Company,	167.0
13. Lowell,	City,	157.4
14. Merrimac,	Town,	31.0
15. Nantucket,	Company,	32.0
16. New Bedford,	City,	1,682.0
17. Newburyport,	City,	105.0
18. Newton,	City,	721.0
19. Northampton,	City,	786.3
20. Northbridge,	Company,	334.0
21. North Adams,	City,	3,942.9
22. North Brookfield,	Town,	144.8
23. Palmer,	Company,	40.0
24. Peabody,	Town,	98.6
25. Scituate,	Company,	42.0
26. Sharon,	Town,	216.5
27. Southbridge,	Company,	307.4
28. Stoughton,	Town,	56.0
29. Taunton,	City,	110.8
30. Uxbridge,	Town,	64.0
31. Waltham,	City,	40.0
32. Ware,	Town,	41.0
33. Westborough,	Town,	90.0
34. Williamstown,	Company,	96.0
35. Winchendon,	Town,	70.0
36. Worcester,	City,	442.0
37. Wrentham,	Town,	42.5

Add to the above the 10 cities and towns which have already had advice from the State Forester.

The Association of American Colleges and Experiment Stations met at Columbus, O., November 15 to 17, and the Massachusetts State Forester was asked to deliver the following paper before said association: —

Forestry: the Part that Colleges and Experiment Stations may play in its Development.

I feel complimented in being asked by the officials of this association to discuss this subject at this time.

I take it for granted at the outset that forestry is already acknowledged to be a subject worthy of consideration by our colleges and universities and well adapted to a place in their curriculum; also that experiment station officials feel that were they able to enlarge their staff by the addition of a forester, results could be expected in this line of agricultural development in their respective States.

Forestry is nothing other than an agricultural crop which demands modern methods of culture and management, as other plants, for both economic and æsthetic results. The forest crop, or forestry, at once calls to mind a large class or group of plants of the vegetable kingdom whose fundamental importance to a State or nation is necessarily closely related to its success and progress. Wood or lumber finds innumerable uses.

When our forefathers came to these shores they found magnificent primeval forests in all their glory, — a vast field of grain waving before the wind as it were. Individual specimens of white pine in New England, Michigan, Wisconsin and Minnesota; black walnut in Ohio, Pennsylvania, West Virginia and Kentucky; black cherry throughout the eastern United States; chestnut from Massachusetts to Georgia; tulip tree throughout the Appalachian range, — all these and many more species could be found that would cut from 3,000 to 6,000 feet board measure from a single tree. What has become of these monarchs of the forest? To-day we point with pride to the forests of the great west and northwest which still remain, but how long will these forests continue to stand, judging from the wasteful methods of the past? Because the east wasted its birthright, now the west claims similar privileges.

We have possessed a nation flowing with milk and honey, figuratively speaking, streams teeming with fish, precious minerals, coal, oil and natural gas in abundance, wild animals and game of a large variety, forests nearly everywhere, excepting on the rich prairies, soils adaptable to most any kind of a crop, etc., and what have we accomplished with this heritage thus far? We have built and established a nation great among the nations of the world. This we Americans are proud of, and we have every reason to be, as our record shows. It was but yesterday our ancestors arrived here, and to-day we are a world power, — in point of time but a brief minute compared with the lives of nations.

In the development of the nation we have not wanted for natural re-

sources; they have been awaiting our use. To an intelligent audience of scientifically trained men like this it is unnecessary to paint any word picture of our development; to simply ask you to give the subject consideration is to call its evolutionary history to mind.

Presidents, directors and workers generally who have co-operative interests in this organization all realize from their life's work the importance of economic utilization and conservation. There is undoubtedly no force that has met our nation's needs and furthered her real fundamental development of permanency more than the work of the institutions represented in this organization.

At the recent National Conservation Congress, held at Kansas City, I was particularly impressed with the fact that the men whom that organization now falls back upon for permanency are largely the product which is the outgrowth of the work of the land grant colleges and experiment stations. Conservation of natural resources is a phrase which has sprung up like a mushroom in the night, and has emphasized, through its popularity and significance, what appeared at the time a new idea. This sudden culmination, however, was made possible through the educational conditions that have been constantly at work during recent years, together with the psychological time in the nation's development.

In presenting the report from Massachusetts at the recent Conservation Congress, I took the liberty of discussing briefly the subject of "Restoration *v.* Conservation of Natural Resources," and as it is more or less applicable, I beg your indulgence in repeating a part of it: —

In Massachusetts the work of restoration is even of more importance than conservation when applied to forestry. The annual cut of our forest products at present amounts to only 5 per cent. of that used each year throughout the Commonwealth for manufacturing, building and other purposes. Surely we can and ought to supply a larger amount of our own home-grown woods. Although the State has been well cut over, even now our present wood harvests play an important factor in the industries of many of our rural sections. While we believe thoroughly in conservation where it will apply, still the more potent force here begins farther back. We need to teach the A B C of restoration in forestry. When our work of reforestation shall have begun to demonstrate its value, it will be an object lesson which will mean much toward perfecting a better State forest policy.

Practical forest restoration, therefore, is what Massachusetts needs most. If we will reconvert our hilly, rocky, mountainous, moist, sandy and waste non-agricultural lands generally into productive forests, the future financial success from rural sections of the Commonwealth is assured. This is no idle dream; it can be accomplished. Massachusetts is a natural forest country, and all that is needed is simply to assist nature, stop forest fires and formulate constructive policies. Then we can grow as fine forests as can be found anywhere. Germany and many of the countries of the Old World have already demonstrated what can be done. Are we to be less thrifty and farsighted? Americans do things when they are once aroused, and it is believed that reforestation and the adopting of modern forestry management must be given its due consideration in this State from now on.

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new idea of "conservation," but to even credit the term or phrase as covering every phase of new endeavor.

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To my mind the phrase "Restoration of natural resources" vies with that of "Conservation of natural resources," and expresses a force to be aroused in the nation for good that in many ways surpasses the present popular one.

We have our forest reserves and minerals that are left, and now to conserve them economically is a worthy undertaking, but in the older sections of the nation to conserve what we have in depleted and worn-out lands and forests is to pick the bones of the withered and shrunken carcass.

Let conservation apply where it may, but the force that is needed in Massachusetts and all of New England, yea, the south, extending even well into the middle of the nation, following the great depleting agricultural cereal and cotton crops on the one hand, and the lumberman's axe and forest fires on the other, is greater than this term can begin to express.

The term "Restoration of natural resources" I claim meets our present needs far better and breathes greater hope and definite accomplishments for our children's children in the future.

Forestry, although it is an agricultural crop and must have greater consideration in the future, has not received the attention it deserves until practically the present time. Forest products have been relatively abundant and cheap in nearly all sections of the nation. Suddenly our needs began to outstrip the supply, and then with advancing prices lumbermen and the public generally have gradually awakened to the necessity of providing for our present and future needs. We find that it is not only a question of harvesting the crop from now on, but one of growing it. There has been little demand for educated foresters in the past as the undertakings were mainly those of economic methods of lumbering.

Saw logs in the early days were 16 inches or more in diameter, while to-day with us in New England lumbermen consider the 5-inch saw log of equivalent value. Box boards, usually cut from white pine, regardless of size of the log or gnarliness of the tree, with wany edges and the bark still adhering, bring more money to-day than did square-edge, clean, clear stock not many years ago. A prominent Boston timber cruiser who has spent the past few years throughout the south called at my office within ten days, and his version of the depletion of the natural forest products of that section was really amazing.

To my mind there are few subjects wherein the organizations represented at this association need to participate more actively than that of forestry. Just because there has not been a definite demand and apparent need until now is not an excuse for present lethargy.

The older members of this association can well remember the earnest and farsighted appeal made to this body by the late Samuel B. Green of

the University of Minnesota, Department of Forestry. Professor Green was particularly anxious that the government be called upon to enact a law whereby each State should have a definite appropriation yearly for carrying on forestry work. The idea was carried as far as presenting the matter before Congress, H. R. 9219, known as the Davis forestry bill. The bill called for an appropriation of $5,000 by the national government, on condition that each State appropriate a like sum. Professor Green said, "When we think of the enormous value of the forest output of this country, the amount requested to educate young men to be competent to take care of this forest wealth seems trivial indeed. I do not wish to see all the agricultural colleges attempting to turn out professional foresters, and such would not be the effect of these proposed expenditures; but the result would be that in a short time we would have a surplus of young men well trained in the basic principles of forestry, through whose efforts the forest sentiment of to-day would crystallize into a permanent and helpful thing."

Do we realize that this plan carried out would mean an expenditure of only $250,000 a year from the national government, and as well furnish an incentive for the States to take advantage of the assistance? This would result in placing the work on a progressive foundation at once.

For some reason we did not take to the idea enthusiastically. There is no legitimate reason even now for not using our present governmental funds for this work, but this might cause necessary adjustment and financial complication. Consequently we have been prone to let well enough alone.

One thing is certain, we are losing valuable time in not having a more definite and well-defined policy of development for forestry throughout the nation. While here and there our most progressive States are doing something in forestry work which example is worthy, and is gradually being followed by others, nevertheless, we are one people, and a fundamental industry so important to the nation's welfare should enlist all educational leaders of rural economics in its behalf.

Economically the forest crop of the future must play a very important part. Those of you who have not had time to study it may be interested in knowing its importance to even a small State like Massachusetts. We have in Massachusetts approximately 5,400,000 acres of land, and of this acreage three-fifths, or practically 3,000,000 acres are unadapted to tillage or general agriculture. These lands, however, under management can all be devoted to forestry. Upon a single acre of such land we have demonstrated, from a thorough study of the white pine, that we can grow 40,000 feet board measure in fifty years, or an average of 800 feet per year. As stumpage is worth from $6 to $12 a thousand at the present time, this would mean an average annual income of from $4.80 to $9.60. Were it possible to practice modern forestry management, therefore, over our entire 3,000,000 acres of forest lands in Massachusetts, it would mean an annual income of from $14,400,000 to $28,800,000. These figures may seem very startling at first, but I offer them for your deliberate con-

sideration. Please remember that the above figures are based on present prices in Massachusetts, and I am willing to leave it to your judgment whether future prices are not likely to be even higher.

What is true of the growth of white pine in the old Bay State is more or less true of forestry conditions elsewhere. When we consider stumpage prices, we must consider, also, that these conditions realized mean economic employment of manual labor, teams and machinery, together with the savings of transportation on raw material and the giving of employment to rural sections during the winter, resulting in an all-year-round occupation.

While Massachusetts does not typify every State it exemplifies that forestry and forest products demand our consideration.

The United States Forest Service has done and is doing splendid work which is having desired results, and many States have well-organized departments of State forestry, but it remains for this association, through its present splendid organization, to become more elastic, welcoming the necessary extension of its curriculum and investigations to include forestry.

I believe that every State should have its State Forester, whose whole time can be spent in determining and carrying out a definite State forest policy. Fire protection and regulation, reforestation and general modern forestry management need constant State supervision and encouragement.

With a national and State organization perfected, the only thing lacking is the great assistance that must come from educating the rank and file of our people, who are to own and manage these forest lands. There are no institutions to which this work more naturally falls than to our land grant colleges and experiment stations. Already these institutions are doing for our people everything possible in every other line of agriculture; then why should not forestry be included with horticulture and agronomy? The department of botany necessarily teaches the fundamentals of the science, and with little additional equipment and assistance any botanical department could give a course in forest botany. What is true of botany is equally true of entomology, physics, plant pathology, etc. Again, I firmly believe that forestry should be required in the agricultural courses to a point sufficient for a comprehensive knowledge of it, allowing students opportunities to specialize later on.

The principles of forestry can readily be taught in our short courses and elementary schools provided the fundamentals of botany, soils and nursery work precede the same. But here, again, this is made possible only through competent teachers, the product from the land grant college or similar institution.

Please do not understand me as an advocate of more forestry schools which endeavor to educate the so-called technical forester, as I believe we have probably enough of this class of institutions already, but that there is a great and growing need for a general forestry education sufficient to practicing modern methods, I am certain.

In Massachusetts, again, I believe we have the ideal arrangement. The State Forester has immediate charge of the shaping and carrying out of

the State forest policy. The State Forester also gives lectures yearly at the agricultural college, covering his field of work. The Massachusetts Agricultural College has a professor of forestry whose privilege it is to see that all students are taught a working knowledge of the subject. Where certain students have shown special proficiency in forestry they undoubtedly, upon graduation, may secure credits in forestry schools, but the college does not claim to turn out a technically trained forester.

By this system of organization I am convinced that very satisfactory results can be realized. There is certainly plenty of work for a State Forester to accomplish without his being tied down to teaching or doing much research work. His work compels him to be familiar with the general State conditions, and the administration of field work in forestry management, reforestation, nursery work, forest insect and disease depredations, the care and management of State forest reserves, forest fire protection, etc. The handling of the forest fire problem alone requires a great amount of supervision to get satisfactory results. The installation and management of lookout stations, the work of securing modern forest fire-fighting equipment for towns and townships, and keeping it properly housed and cared for so as to be effective for proper and efficient patrol systems in dry times; all these demand constant attention. To keep a forest fire system effective the State Forester must be in close touch with the working unit. What is true of forest fires is equally true of seeing that forest working plans are properly executed, and that all forestry practices are performed in a practical way.

It therefore remains for the professor of forestry to do the teaching of students, and the station forester or the station botanist, entomologist or pathologist to undertake the lines of pure investigation. With this definitely outlined plan results are bound to come.

In closing, I simply desire to appeal to this association in behalf of a more wholesome position than we have yet reached in recognizing forestry or the forest crop as needing and deserving more attention than we are at present giving it.

New Forestry Legislation.

The following new legislation was enacted by the last General Court.

Law relative to setting Fires in the Open Air.

The law relative to setting fires in the open air was amended at the last session of the General Court so as to apply to all cities and to such towns as accepted the provisions of the act at a meeting of the voters called for that purpose. The time at which such permits are necessary was also changed, so as to include the month of March. The law as now in force is as follows: —

Chapter 209.

An Act relative to the Setting of Fires in the Open Air.

Be it enacted, etc., as follows:

Section 1. It shall be unlawful within any city, or within any town which accepts the provisions of this act, for any person to set a fire in the open air between the first day of March and the first day of December except by the written permission of the forest warden, or the chief of the fire department or, in cities that have such an official, the fire commissioner: *provided*, that debris from fields, gardens and orchards, or leaves and rubbish from yards may be burned on ploughed fields by the owners thereof, their agents or lessees; and *provided, further*, that persons above eighteen years of age may maintain a fire for a reasonable purpose upon sandy or barren land, if the fire is enclosed within rocks, metal or other non-inflammable material. In every case such fire shall be at least two hundred feet distant from any forest or sprout lands, and at least fifty feet distant from any building, and shall be properly attended until it is extinguished. The forest warden shall cause public notice to be given of the provisions of this section, and shall enforce the same. Whoever violates the provisions of this section shall be punished by a fine of not more than one hundred dollars, or by imprisonment for not more than one month, or by both such fine and imprisonment.

Section 2. Said chapter two hundred and nine is hereby further amended by striking out section four and inserting in place thereof the following: — *Section 4.* The state forester and forest warden, or any duly authorized assistant in the employ of the state forester, or any duly appointed deputy forest warden, may arrest without a warrant any persons found in the act of setting or maintaining a fire in violation of the provisions of this act.

Section 3. Said chapter is hereby further amended by striking out section five and inserting in place thereof the following new section: — *Section* 5. The selectmen of every town may submit this act to the voters for their acceptance at any annual or special town meeting. The vote shall be taken by separate ballot, and shall be "Yes," or "No" in answer to the following question printed upon the ballot: "Shall an act passed by the general court in the year nineteen hundred and eight, entitled 'An Act to provide for the protection of forest or sprout lands from fire,' be accepted by this town?" A majority vote of the legal voters present and voting at such meeting shall be required for the acceptance of this act; and upon such acceptance the provisions of section twenty-four of chapter thirty-two of the Revised Laws shall cease to apply to any town which has previously accepted that section.

Section 4. Section eleven of chapter two hundred and eleven of the Revised Laws is hereby repealed.

Section 5. This act shall take effect upon its passage. [*Approved April 6, 1911.*

Rulings.

As the validity of this law has been doubted by some people on technical grounds, I desire to call attention to three cases which have been brought before the courts of the Commonwealth during the past season, and the disposition made of them.

Soon after the act was amended by the Legislature, a fire was set by a man in Boxford without a permit, which got beyond his control, and not only burned over a large area of valuable forest land, but cost the lives of two men who were working to suppress it. The party who set the fire was arrested and brought before the court at Haverhill, where his counsel attempted to have the case *nol prossed* on the ground that while the town of Boxford had accepted by vote the provisions of the act of 1908, it had failed to take any action on the amendment of 1911; consequently his client could not be held criminally liable. Judge Ryan, who presided over the case, heard the evidence, and then reserved his decision for a week in order that he should have ample time to consider the case thoroughly, at the end of which time he adjudged the defendant guilty, and imposed a substantial fine.

Another case, identical with the above, was brought before Judge Burke at Pittsfield. In this case the defendant was fined \$20; he appealed to the higher Court, where the verdict of the lower court was sustained, although the fine was reduced to \$15.

The third case was one brought before Judge Field at Greenfield. In this case the defendant was dismissed.

In order to have the construction of the law settled, the State Forester asked the Attorney-General's opinion, which was rendered on Dec. 18, 1911.

Attorney-General's Opinion.

BOSTON, Dec. 18, 1911.

F. W. RANE, Esq., *State Forester.*

DEAR SIR: — You submit for my consideration certain questions with regard to the construction of St. 1908, c. 209, as amended by St. 1911, c. 244. Your first inquiry is as follows: —

Does the act of 1911 (chapter 244), which struck out section 1 of chapter 209 of the Acts of 1908, substituting a new section therefor, make it necessary for towns that had accepted the act of 1908 to accept the amendment of 1911, or is the amended act operative in such towns without further action?

St. 1908, c. 209, was entitled "An Act to provide for the protection of forest or sprout lands from fire," and provided in section 1 that in a town which accepted its provisions or had accepted corresponding provisions of earlier laws no fires should be set in the open air between the first day of April and the first day of December, except by the written permission of the forest warden, except that debris from fields, gardens and orchards, or leaves and brush from yards, might be burned on ploughed fields by the owners, their agents or lessees, provided such fire was at least 200 feet from any forest or sprout lands, and was properly attended until it was extinguished. Section 5 provided that the selectmen of every town should cause the act to be submitted to the voters for their acceptance at the next annual meeting of the town after the passage thereof; and that a majority vote of the legal voters present and voting at such meeting should be required for its acceptance. These sections were amended by St. 1911, c. 244. Section 1 repealed the whole of the first section of the earlier act and substituted in its place a provision that —

> It shall be unlawful within any city, or within any town which accepts the provisions of this act, for any person to set a fire in the open air between the first day of March and the first day of December except by the written permission of the forest warden, or the chief of the fire department or, in cities that have such an official, the fire commissioner: . . .

This section was substantially similar to the section struck out, but contained the additional exception that persons above eighteen years of age might maintain a fire for a reasonable purpose upon sandy or barren land if the fire was enclosed within rocks, metal or other non-inflammable material, and was otherwise slightly changed in phrase therefrom. Section 3 of chapter 244 repealed section 5 of the earlier act and substituted therefor the following new section: —

> The selectmen of every town may submit this act to the voters for their acceptance at any annual or special town meeting. The vote shall be taken by separate ballot, and shall be "Yes" or "No" in answer to the following question printed upon the ballot: "Shall an act passed by the general court in the year nineteen hundred and eight, entitled 'An Act to provide for the protection of forest or sprout lands from fire,' be accepted by this town?" A majority vote of the legal voters present and voting at such meeting shall be required for the acceptance of this act; and upon such acceptance the provisions of section twenty-four of chapter thirty-two of the Revised Laws shall cease to apply to any town which has previously accepted that section.

I am of opinion that the amendments so enacted do not disclose any intention upon the part of the Legislature to require an additional acceptance thereof from towns which had accepted the statute amended. Where an act, the operation of which in any particular municipality or division of government is conditioned upon acceptance by such municipality or other division of government, has been accepted, it becomes a law, and, apart from questions affecting the constitutionality of the subject-matter

of an amendment, may be amended or repealed at the pleasure of the Legislature. It follows, therefore, that the amendment of 1911 is applicable to all towns which had accepted St. 1908, c. 209, without further action by such towns.

Your second inquiry is as follows: —

Does the provision in section 1, which allows the burning of debris, leaves and rubbish from fields and orchards, when 200 feet from sprout land or 50 feet from a building remain in force throughout the year? Does that provision apply to all towns, or only those that have accepted the act?

The provision to which your second question is directed, that "debris from fields, gardens and orchards, or leaves and rubbish from yards may be burned on ploughed fields by the owners thereof, their agents or lessees," is an exception from the restriction upon the setting of fires between the first day of March and the first day of December, contained in the same section, and it follows, therefore, that an owner, agent or lessee may at any time during the year burn debris from fields, gardens and orchards or leaves and rubbish from yards on ploughed lands, provided that such fire shall be at least 200 feet distant from any forest or sprout lands and at least 50 feet distant from any building, and shall be properly attended until it is extinguished. Whether or not during the period from the first day of December to the first day of March fires may be set which do not in all respects comply with the provisions referred to, your question does not require me to decide. Since St. 1908, c. 209, as amended by St. 1911, c. 244, has the force of law only in towns which have accepted or may accept its provisions, it follows that the particular restriction with respect to setting of fires does not apply to all towns, but only to those which have accepted the act.

Your third inquiry is as follows: —

Does the striking out of sections 4 and 5 of the act of 1908 and substituting new sections affect in any way the application of the law in towns that have accepted the act?

St. 1908, c. 209, § 5, permitted an acceptance of its provisions only "at the next annual meeting of the town after the passage of this act," to wit, at the next annual meeting after March 14, 1908. The obvious purpose of the amendment contained in St. 1911, c. 244, § 3, is to provide that the question may be submitted to towns which did not avail themselves of the provisions contained in the earlier statute, "at any annual or special town meeting." There is nothing in its language which discloses any intent upon the part of the Legislature to require towns which had already accepted the provisions of the earlier act to reconsider the question.

Very truly yours,

JAMES M. SWIFT,

Attorney-General.

Law providing for Better Forest Fire Protection.

What is considered by many to be the most valuable piece of legislation relating to forestry that has been enacted for many years is the law which empowered the State Forester to appoint an assistant to have charge of the forest fire problem in Massachusetts, aided by an efficient corps of deputies. The work already accomplished under this law is extremely gratifying, and, with the system and organization planned for next season put in operation, will without doubt result in reducing very materially the losses we have annually suffered from forest fires. The following is the law in full: —

CHAPTER 722.

AN ACT TO PROVIDE FOR THE BETTER PREVENTION OF FOREST FIRES.

Be it enacted, etc., as follows:

SECTION 1. The state forester is hereby empowered to appoint an assistant to be known as the state fire warden, whose special duty it shall be to aid and advise the forest wardens and their deputies in towns and the municipal officers exercising the functions of forest wardens in cities, in preventing and extinguishing forest fires and in enforcing the laws relative to forest fires, and may from time to time designate not more than fifteen deputies to aid such state fire warden in the discharge of his duties.

SECTION 2. The state fire warden appointed under the terms of section one shall report annually upon his work and upon the forest fires occurring in the commonwealth, and his report shall be included in and be printed as a part of the state forester's annual report.

SECTION 3. The deputies of the fish and game commissioners shall report to the state fire warden the situation and extent of any forest fire occurring within the district to which they are assigned, and they shall report to him monthly their doings under chapter two hundred and ninety-nine of the acts of the year nineteen hundred and seven.

SECTION 4. The sum of ten thousand dollars is hereby appropriated to carry out the provisions of this act during the year nineteen hundred and eleven.

SECTION 5. This act shall take effect upon its passage. [*Approved July 18, 1911.*

Constitutional Amendment relative to the Taxation of Wild or Forest Lands.

The desirability of a change in the method of taxing forest lands in Massachusetts was clearly shown by the report of a special committee appointed in 1905 to investigate the subject, and the

benefits to be derived from a system less burdensome than that now in vogue have been pointed out by the State Forester many times in his annual reports. His Excellency Governor Foss, in a special message, urged upon the Legislature of 1911 the importance of giving this question prompt and serious consideration. He recommended a constitutional amendment which would enable the General Court to enact such legislation relative to the methods of taxing wild or forest lands as will serve best to encourage the development of forestry in the Commonwealth. The following resolve, based upon the Governor's message, was passed by both branches of the Legislature: —

RESOLVE TO PROVIDE FOR AN AMENDMENT OF THE CONSTITUTION RELATIVE TO THE TAXATION OF WILD OR FOREST LANDS.

Resolved, That it is expedient to alter the constitution of the commonwealth by the adoption of the subjoined article of amendment; and that the said article, being agreed to by a majority of the senators and two thirds of the members of the house of representatives present and voting thereon, be entered on the journals of both houses, with the yeas and nays taken thereon, and be referred to the general court next to be chosen; and that the said article be published, to the end that if agreed to in the manner provided by the constitution, by the general court next to be chosen, it may be submitted to the people for their approval and ratification, in order that it may become a part of the constitution of the commonwealth.

ARTICLE OF AMENDMENT.

Full power and authority are hereby given and granted to the general court to prescribe for wild or forest lands such methods of taxation as will develop and conserve the forest resources of the commonwealth.

SENATE, July 6, 1911.

The foregoing article of amendment is agreed to, a majority of the senators present and voting thereon having voted in the affirmative; and the same is referred to the general court next to be chosen.

ALLEN T. TREADWAY, *President.*

HOUSE OF REPRESENTATIVES, July 13, 1911.

The foregoing article of amendment is agreed to, two thirds of the members of the house of representatives present and voting thereon having voted in the affirmative; and the same is referred in concurrence to the general court next to be chosen.

JOSEPH WALKER, *Speaker.*

The passing of the foregoing legislation by the present General Court is believed to be of great importance by the State Forester. In order to give the State Forester's opinion more in detail, the following letter is published, which was alluded to in Governor Foss's message: —

Governor Eugene N. Foss.

Dear Sir: — In reply to your request for a statement of my opinions concerning forest taxation in this State, I submit the following: —

Of the Massachusetts 5,400,000 acres, as far as I am able to ascertain practically three-fifths, or at least 3,000,000 acres, are better adapted to forestry than any other purpose. We have a naturally rolling country, and from its geological formation much of our lands are either hilly, rocky, mountainous, sandy or moist, so that they are unadapted for general agriculture. These same lands, however, were originally covered with splendid stands of primeval forests, and under modern methods of management we have every reason to believe can be made a great fundamental asset to the State's future.

We have in Massachusetts a natural forest country. From a study of the white pine as found growing naturally in the State, we have statistics in the State Forester's office that show very conclusively that were we able to keep our lands adapted to forests, growing this species alone, the average annual increment of growth would range from 751 feet board measure under slow-growing conditions to 1,130 feet under fast-growing conditions for each acre. The above data were for yearly averages of fifty-year growth stands.

When we realize that at present white pine averages from $6 to $12 per thousand for stumpage, one can appreciate what values are possible in even a small State like Massachusetts if properly regulated. What is true of the white pine is more or less true of other forest species. The above data are taken from natural conditions.

It is well known by foresters that under modern methods of forestry management, like that pursued by the Germans, greater yields can be depended upon. From our present knowledge of forest production, and its bearing upon Massachusetts, we believe it a conservative statement to say that were we able to control forest fires, insect and disease depredations, and to practice modern forestry management, we could expect the average yearly income to the State at present prices to range from $10,000,000 to $25,000,000. We are reasonably sure, as well, that future prices of forest products will be much higher than at present.

The conditions of our present forest taxation are extremely elastic. In many towns the tendency is to place a heavy valuation on timber lands, while here and there we find that little change has been made for a number of years, although the true valuation has greatly increased. Instances are shown where forests have been taxed at a nominal sum until pur-

chased at a fair price, and then the valuation is raised, in some instances to an advance of 60 per cent.

The tendency at present is to increase valuations on forest lands more than formerly, as good growth is scarce, and if assessors tax it at its real value, according to law, owners at once realize the burden and are driven to cut it down. If these conditions applied to mature growth the objection would be slight, but our old growth is largely cut, and the burden comes on young and immature growth that from every economic standpoint, including that of rational taxation, should not be cut.

The objectionable feature to our present system is the taxing of the growing crop as well as the land. Growing agricultural crops are not taxed. The forest is nothing other than a growing agricultural crop, only that the crop of each additional ring on the trees or increment cannot be harvested without destroying the possibilities of future crops or values, and hence remains dormant until the totals of several seasons are taken together. Were it not for this fact the growth of each year would not be taxed any more than other agricultural crops. Therefore, just because there is in a tree crop an accumulation of annual growing crops, which from the nature of the case is necessarily standing idle to ensure the succeeding annual growing crop on the same land, it should not be taxed.

Farm lands are assessed at a fair average figure per acre, depending upon their productivity of crops, and, as above stated, the crop is not taxed. Why not tax forest lands, or even depleted and neglected lands capable of growing forests, of which there are many throughout the State, at the rate of their annual possibilities of productivity, the same as agricultural lands are now taxed? This would determine a basis of yearly permanent taxation on which the towns and State could depend. It would go farther; it would establish a definite policy whereby one could be assured of a reasonably certain policy in dealing with forest properties.

Our present law, if enforced by conscientious assessors, results in premature harvesting of the crop, as not only is the growing annual crop taxed, which in itself would not be so objectionable, even if other agricultural crops are exempt, but this growing crop is again taxed year after year when it is standing idle, and this fact is distinctly burdensome to modern forestry development.

A point I wish to emphasize relative to the importance of having a well-regulated State forest policy, which is impossible with our present uneven taxation law, is that modern forestry encouraged is bound to return an industry to our rural communities, the lack of which is already experienced at the present time.

It was only a few years ago when every farming district was equally busy in winter as throughout the growing season, utilizing its hired help and teams in the wood lot, getting out saw logs and lumber; not stripping the land, but taking out the ripe trees suitable for lumber, and carrying on a rotation of crops in the forests as it were. The farmer had an industry to follow in the winter as well as in the summer. At present the depleting, or run-out at the heel, forestry conditions, once so thrifty, have, through

improper culture, left many a rural town without a winter occupation. The hired help which once the farmer was able to retain throughout the whole season is lost during the present winters, and even the horses and oxen are "eating their heads off," instead of being needed for the accustomed purpose of industry. A more rational taxation of forests, I believe, will have a tendency to better the whole rural life problem.

I came to Massachusetts as State Forester the year following the report of the committee of 1905, which was appointed by the General Court to consider the laws relative to the taxation of forest lands. After studying the report, and looking into the matter quite fully, I became convinced that the whole question was one of larger importance, namely, that before we could arrive at the problem satisfactorily from the forestry standpoint, it would be necessary to be able to classify the forestry properties in such a manner as to render practical results. This, I found, is not allowable according to the State Constitution, and it was for this reason that I took the position that I did before the taxation commission, which reported in December, 1909.

Respectfully submitted,

F. W. Rane,

State Forester.

April 26, 1911.

Expenditures and Receipts.

In accordance with section 6, chapter 409 of the Acts of 1904, as amended by section 1, chapter 473 of the Acts of 1907, the following statement is given of the forestry expenditures for the year ending Nov. 30, 1911: —

Salaries of assistants,	$5,335 70
Traveling expenses,	741 73
Stationery, postage and other office supplies,	593 93
Printing,	159 92
Nursery account,	3,075 28
Sundries,	119 28
	$10,025 84

Reforestation Account.

Labor,	$5,679 54
Land,	675 00
Trees,	2,048 23
Tools,	323 08
Travel,	767 68
Express,	417 91
Sundries,	83 63
	$9,995 07

Forest Fire Prevention.

Salaries,	$3,440 27
Travel,	2,287 02
Printing,	378 80
Stationery, postage and other office supplies,	468 92
Express,	34 59
Equipment,	2,461 67
Sundries,	52 47
	$9,123 74

Reimbursements to towns for fire-fighting apparatus,	$3,424 54

Respectfully submitted,

F. W. RANE,
State Forester.

TWENTIETH SEMIANNUAL REPORT

OF THE

CHIEF OF THE CATTLE BUREAU.

PRESENTED TO THE BOARD AND ACCEPTED,
JANUARY 9, 1912.

REPORT.

BOSTON, Jan. 9, 1912.

To the State Board of Agriculture.

I have the honor to present for your consideration the twentieth semiannual report of the Chief of the Cattle Bureau. It is also, as you are aware, the second annual report bearing my signature as head of the department, and embodies in its scope the statistics of the work of the Bureau for the fiscal year ending Nov. 30, 1911.

In my first report to your honorable body made one year ago it was impossible to speak of work accomplished, as I had then been at the helm but two months. Necessarily, I could only tell you something of what I hoped to do, to point out sundry changes in methods that seemed to me desirable, and to outline partly a policy for the future. Standing then upon the threshold of the work my report was largely tentative and sketchy. To-day after a year of studious application to my official duties I feel justified in speaking with a definiteness born of experience.

The department, the administration of which I have been charged with through appointment by one Governor and reappointment by his successor, has received my constant attention, and my sense of its importance as guardian of the animal industry of the State has steadily increased. I am more firmly convinced than ever that in its relation to the public its importance cannot be overestimated.

My first full year of service has seen sundry changes in policy established, all of which have passed the frictional stage and are working successfully, and has likewise demonstrated that still other changes are necessary. In this connection I should like to make a record of the fact, which is already known to you, and of which I am proud, that every petition for legislation emanating from the Cattle Bureau

last year was, after running the gauntlet of committee investigation, favorably reported and enacted into law. This unbroken line of successes would seem to demonstrate that the bills asked for were reasonable, and appealed to the good sense and calm judgment of the Legislature.

By the provisions of one of the year's enactments originating from this department, mange was included in the list of contagious diseases recognized as such by the Commonwealth. This was asked for because of the alarming prevalence of the disease among cattle, a condition that was seemingly being overlooked if not ignored. My own experience as a raiser of cattle and a dairyman had taught me the importance of opposing its spread with direct and prompt action. It can be stated with absolute truth that since the new classification of this disease the efforts made by the Cattle Bureau for its suppression have been attended with gratifying results.

Another law for which we asked and which we were granted clothed the Chief of the Bureau with greater power in the matter of the appointment of local inspectors by city and town officials. This has resulted in maintaining the efficiency of the department by retaining in office tried and capable men who otherwise would have been forced out under local political pressure. In some instances it has enabled us to substitute more efficient men for nonefficients who held their places in payment of political debts. In most cases this has been accomplished without material friction, and in all cases the amended law has made it possible for the department to maintain its standard of local inspection work. It seems hardly necessary to say to your honorable Board that if desirable results are to be attained there must be harmony between the officer of the State and the appointee of the city or town, a condition now made possible under this statute.

A third bill transferred to the State Board of Health certain duties in connection with the supervision of slaughterhouses formerly vested in this department, thus placing the responsibility upon one board instead of dividing it between two, and at the same time removing all cause for conflict of authority.

Still another bill, also in the line of intelligent classifica-

tion of work and fixing of responsibility, was one of which I am very proud, and in which I am confident you will be greatly interested. Under the old régime the Cattle Bureau inspector had no authority to enforce the improvement of sanitary conditions in barns, stables or other buildings where neat cattle are kept, the control of such improvement being assumed by the State Board of Health under the guise of protection of the milk supply. Under that arrangement conditions were not always improved. Chapter 381, Acts of 1911, a bill originating from this Bureau, conferred upon this department definite authority to make all reasonable rules regulating conditions in farm buildings where cattle are housed, and this has been supplemented by Cattle Bureau Order No. 30, recently approved by the Governor and Council, which empowers the Chief of the Cattle Bureau to enforce any and all changes of a sanitary nature that may to him seem wise. I shall use this power with discretion. I am by profession a farmer, and I have had a lifelong and intimate association with the trials, disappointments and reverses the farmer is bound to encounter. I shall not rashly attempt to correct or regulate the business of my brother farmer. I know many men, and they have my sympathy, who have given up the dairy business in disgust rather than submit to the arbitrary dictation of some theoretical inspector whose sole object in life seemed to be to make all the trouble possible regardless of results attained. I have sought (and in most cases have succeeded) to foster co-operation between the individual and the Bureau. I instruct the Bureau agents to proceed with a determination to enlighten rather than to frighten those with whom they have to deal. Much of the success under this section of law depends upon the character of the men employed.

Under this act I have appointed a number of district agents, covering various sections of the State, whose duty it is, in addition to regular departmental work, to make thorough examinations of farm buildings with reference to their hygienic condition, consult with the owner, advise as to needed changes along practical lines, and explain the benefits which will accrue if such changes are made. It gives me

pleasure to report that out of a large body of applicants for the position of district agent I was able to secure an excellent corps of men. They are nearly all veterinarians by profession, who possess in addition to a scientific training a fund of good, sound, common sense, the combination making them of great value in securing the results contemplated by the Legislature under this act.

I am looking for, and believe I shall receive, great beneficial results when the people are fully informed as to their duty, and the power of corrective enforcement conferred upon this Bureau. While I sympathize with the good-intentioned farmer who for financial reasons cannot meet the demands of the latest fads in barn sanitation, but who is willing to do the best he can with his available means, I do not lose sight of the fact that there are hundreds of places in which conditions are undesirable. This will continue to be so until it is generally understood that there is only one department in the State charged by statute with authority in the matter, and other boards, both state and local, display a willingness to co-operate with that department rather than conduct duplicating efforts which, because these boards lack the power of enforcement, must necessarily prove abortive. In spite of the reports freely circulated that the country barn is generally unsanitary, the records of the Bureau inspectors show beyond question that the most undesirable conditions in the State are often found within city limits, where for political or other reasons filthy stable premises exist undisturbed, while the country farmer who is supplying milk in the same city is continually harassed, although he knows his product is far superior to that of his urban competitor. These unfair conditions must cease, or the cattle and milk industry will dwindle into insignificance. The Cattle Bureau has been clothed with power to better conditions, and it purposes making a strenuous fight to accomplish that result. It is desirable that the machinery now directed by the Cattle Bureau be not handicapped in the future by attempts on the part of any organization to usurp the authority vested by statute in the Bureau. I am confident this department, if

allowed to handle this branch of the State's work without interference, will do it with credit to itself and honor to the Commonwealth.

RECOMMENDATIONS.

At the proper time I shall embody in several bills for legislative consideration a number of matters that have developed during the year, and seem to demand correction. It is proper that I should lay them before your honorable body.

As I have explained at length, the hygienic and sanitary improvement of buildings where cattle are housed has been vested in the Cattle Bureau by the provisions of chapter 381, Acts of 1911. Under this law marked progress has been made and still greater may be reasonably expected if the individual can be made to feel that the State as represented by the Bureau is a friend to be heeded rather than an enemy to be feared. I would recommend that an appropriation be granted by the State which may be used in small sums as gratuities to be paid to such owners as show in the year the greatest improvement in sanitary conditions in their farm buildings. This I am confident would prove to be an incentive to greater effort along this line, and would foster the tie between the State and individual by teaching that the Commonwealth's policy is one of premiums rather than punishments.

I have earlier in this report, in connection with the regulation of sanitary conditions in barns and other premises where neat cattle are kept, dwelt upon the desirability and advantages of a law uniform in its application to all cities and towns throughout the State, with the administration of it and the responsibility for it vested in central and individual authority. The Cattle Bureau was established to have charge and oversight of the animal industry of the State. It is held responsible for the hygienic condition of all live stock within the State, and the term "live stock" embraces horses as well as cattle, and to this department is assigned the duty of guarding against the disease known as glanders and farcy. Yet in this latter case the department is circumscribed in its

action and in its authority. By an act passed in 1899 (section 14, chapter 408, Acts of 1899) the control of glanders, farcy and rabies in the city of Boston was taken out of the jurisdiction of State authority and placed under the authority of the local health board of that city. In regard to glanders, the Cattle Bureau, while it is fighting the disease elsewhere in the State, and endeavoring under the most eminent veterinary advice to stamp it out, is confronted by the record that, while only about 9½ per cent of all the horses in the State are to be found in the city of Boston, 40 per cent of all the cases of glanders occurring in Massachusetts last year were located in Boston. The startling proportion of such cases in the capital city of the State handicaps the work of the Cattle Bureau outside the limits of Boston, and it may be asserted with confidence that no material advance towards eradication of the menacing evil is likely to be made so long as there is divided responsibility. In my opinion better and speedier results would follow if Boston were placed in charge of the Cattle Bureau (as is the rest of the State) in the matter of glanders control. I believe that the Legislature in its wisdom will eventually come to see the desirability of clothing the Cattle Bureau with as wide power in the control of glanders as it has already conferred in cases of tuberculosis in the herds of the Commonwealth, and it is not improbable that, subsequent to such legislative action, a law will be enacted providing for just and equitable compensation for such animals as are killed by order of the State because they are affected with glanders.

One other recommendation will be presented to the Legislature of 1912. The Chief of the Bureau is now appointed for a term of one year. This, in my opinion, militates against the efficiency of the department. Changes of policy are wrought out through experiment, and policies, definite, economical and effective, can only be established after they have been tested. If the ideal in this department is to be attained, a longer tenure of office should be assured. At the proper time a bill will be introduced calling for a term of sufficient length to ensure the firm establishment of a definite policy, and the same bill will provide for a compensation

commensurate with the important nature of the work, and justifying the incumbent, whoever he may be under the contemplated reorganization, in giving his entire time to the solution of the varied and complex problems that will constantly confront him.

Section 12, chapter 90 of the Revised Laws, as amended by section 1, chapter 143, Acts of 1911, provides that inspectors of animals of any city or town may be removed by local officials without cause. This section should be amended by striking out the last sentence, thereby insuring the continuance in office of an inspector, unless he refuses or neglects to be sworn, or does not properly perform his duty.

Appended will be found comprehensive tabulated data of the daily work of the Bureau's agents, as carefully compiled by the assistants in the office. I wish to record here my appreciation of the loyalty of the office attachés, and of all connected with the work of the Bureau throughout the State. I appreciate also the hearty co-operation accorded my efforts by members of this Board. Your support, gentlemen, at all times has given me courage to continue the fight for the preservation and upbuilding of the cattle industry of the Commonwealth.

Rabies.

The following table shows the prevalence of rabies during the year ending Nov. 30, 1911: —

	Dogs.	Cattle.	Cats.	Horses.
Killed or died with rabies,	121	3	3	3
Killed by owners or died in quarantine, not rabid,	50	4	2	1
Released from quarantine,	47	1	–	–
Animals still in quarantine,	11	–	–	–
Totals,	229	8	5	4
Grand total,	246 animals.			

There has been an increase in the number of cases of rabies in dogs over last year, the greater part of which occurred in the Merrimac River valley; namely, 69 cases

out of a total of 121 occurred in towns lying wholly or in part in this valley.

One case of dumb rabies was reported from Newton, and upon investigation it was found that the dog had been purchased in New York City about a week before.

Dr. Alex. Burr, of the health department of Boston, reports 4 cases of rabies in dogs in that city during the year ending Nov. 30, 1911, making the entire total number of cases of rabid dogs 125.

During the year Dr. Langdon Frothingham has examined the brains of 61 dogs, of which 43 proved positive cases and 18 have proved to be negative. Two heads of dogs suspected of being rabid were sent in for microscopical examination that were found to be in such bad condition that a diagnosis could not be made.

The records show that no less than 50 persons, mostly children, were bitten by rabid dogs, or so exposed by handling the animals that it was deemed advisable to recommend the Pasteur treatment.

The above statement cannot fail to impress the reader with the seriousness of the situation in such localities as become infected with rabies, and with the great importance of drastic action on the part of local authorities to the end that, during the period of outbreak, all dogs be so thoroughly and completely restrained as to prevent any and all intercourse between them, and in that way tend to suppress and eradicate the disease more speedily and thoroughly than can be accomplished by less severe measures.

Glanders.

The subject of glanders is one to which I have referred earlier in this report, and I shall here only reiterate my statement of the grave importance of more satisfactory methods for handling this disease, having in mind the eventual eradication rather than the temporary suppression and control of the disease. The appended statements give briefly the results of the work of the department along this line during the year ending Nov. 30, 1911: —

Thirteen hundred and seventy horses and mules have been

reported as suspected of having glanders or farcy, including those dealt with in stable tests. Of these, 946 were killed or died, and found to be affected with this disease; 380 were released after examination, and 44 held for further observation. Of 24 horses held over from last year, 6 later developed the disease and were killed or died, and the remaining 18 were released as free from disease, making a total of 952 killed, or which have died, during the year. Of this number, 387 were reported from the city of Boston.

Fourteen stable-tests were made during the year, 226 horses having been tested with mallein, 18 of which developed the disease sufficiently to warrant their destruction.

At the present time the Bureau is investigating the value of the recently recognized test for the diagnosis of glanders called the "complement-fixation" test, and has had specimens of blood taken from horses in stables in various parts of the State where the infection has existed.

The reports of rendering companies, as required by section 111 of chapter 75 of the Revised Laws, as amended by chapter 243 of the Acts of 1907, continue to be of much value in furnishing information of cases of glanders or farcy, which would not otherwise be brought to the attention of the Chief of the Cattle Bureau, as the following table illustrates: —

Reports of Rendering Companies.

Rendering Companies.	Number of Reports.	Number of Cases.	Number in Boston.	Number out of Boston.	Number outside of Boston not previously reported.
C. S. Bard, Haverhill,	5	9	–	9	1
William S. Higgins, Saugus,	16	11	–	11	–
Home Soap Company, Millbury,	18	10	–	10	–
Lowell Rendering Company,	4	1	–	1	–
A. G. Markham, Springfield,	4	4	–	4	2
James E. McGovern, Andover,	32	12	–	12	1
Muller Brothers, North Cambridge,	33	106	5	101	11
New Bedford Extractor Company,	4	5	–	5	1
New England Rendering Company, Brighton,	21	85	28	57	29
Parmenter & Polsey Fertilizer Company, Peabody,	6	6	–	6	1
N. Roy, Jr., South Attleborough,	40	85	–	85	23
N. Ward Company, South Boston,	50	333	287	46	7
Whitman & Pratt Rendering Company, North Chelmsford,	9	9	–	–	2
S. Winter, Brockton,	3	3	–	–	1
Worcester Rendering Company,	16	20	–	–	6
Totals,	261	699	320	347	85

Annual Inspection of Neat Cattle, Farm Animals, and Premises upon which the Former are kept.

Near the close of December, 1910, the following circular letter was sent to the inspectors of animals in the cities and towns of the State, together with the necessary books in which to record the results of their work, and blank forms of certificates of health to be given owners in conformance with section 18, chapter 90 of the Revised Laws: —

Commonwealth of Massachusetts,
Cattle Bureau of the State Board of Agriculture,
Room 138, State House, Boston, Dec. 27, 1910.

Directions to Inspectors of Animals.

Inspectors of animals are hereby directed to make a general inspection of the neat stock and incidentally other farm animals in their respective towns, as required by chapter 90 of the Revised Laws, such inspection to commence February 1 and *to be completed before the fifteenth day of March.*

Wherever inspectors examine animals and find them free from contagious disease, they will give owners certificates of health, as provided for in section 18 of the law, from the book of blanks (Form No. 2) furnished for that purpose. Books will also be provided (Form No. 1) for carrying out the provisions of sections 17 and 24 of chapter 90 of the Revised Laws.

Inspectors *will not say* on any report, "Same as last year," but will make a *full* and *complete report* on *every place* inspected, including all *dimensions* and *measurements* provided for on the blank, and *answer in full all questions* as to the *light, ventilation, sanitary surroundings,* and *water supply,* as well as the *number* of *cattle* kept in each stable, and give a complete list of other animals in spaces provided in the book.

Inspectors of animals are not to quarantine any cattle as tuberculous, unless they show sufficient evidence of disease to make it possible to condemn them on a physical examination, or show evidence of tuberculosis of the udder.

It is also requested that, if cases of tuberculosis in animals are found, inspectors keep a record of them for a few days, and then when animals are quarantined, several can be quarantined at once and duplicates sent here, so that the agent of the Cattle Bureau can see a number at one visit, instead of having to go every two or three days to see one animal at a time, thus avoiding running up expenses as much as possible.

It is also the duty of inspectors of animals to quarantine cattle brought into this State from without the limits of the Commonwealth, if the owner has not had a permit from this Bureau, the same to remain in quarantine until ordered released by the Chief of the Cattle Bureau or his agent.

Inspectors of animals, in case they suspect the presence of *any contagious disease among any species of domestic animals,* are to quarantine such animals and send duplicates to the Chief of the Cattle Bureau.

Contagious diseases, under the provisions of section 28, chapter 90 of the Revised Laws, include "*glanders, farcy,* contagious pleuro-pneumonia, tuberculosis, Texas fever, foot-and-mouth disease, rinderpest, hog cholera, *rabies,* anthrax or anthracoid diseases, sheep scab and actinomycosis."

The necessary books for the inspection will be forwarded at once. Please report immediately if not received by February 1. When inspection is completed return book, Form No. 1, at once *by express prepaid.*

Fred F. Walker,
Chief of Cattle Bureau.

The following table embodies a condensed report of the doings of the inspectors of animals in making the annual inspection, which complies with the requirements of section 24, chapter 90, Revised Laws: —

Net Results of Annual Inspection of Animals and Farm Premises.

Number herds inspected,	30,593
Number neat cattle inspected,	228,690
Number cows inspected,	213,032
Number herds kept clean and in good condition,	25,224
Number sheep inspected,	25,144
Number swine inspected,	73,705
Number goats inspected,	892
Number stables inspected,	32,676
Number stables well located,	28,768
Number stables well lighted,	25,442
Number stables well ventilated,	27,181
Number stables kept clean,	27,270
Number stables with good water supply,	30,299
Number stables improved since last inspection,	974

Tuberculosis.

The work for the eradication and control of bovine tuberculosis can, as usual, be grouped under three heads: *first,* the examination of animals quarantined by the local inspectors on suspicion of being diseased, and the appraisal and condemnation of those found by the agents to be tuberculous; *second,* the quarantining and testing of cattle intended for dairy or breeding purposes, brought into Massachusetts from other States to the stock yards at Brighton, Watertown or Somerville, and those brought in on permits to other points; *third,* testing cattle with tuberculin for owners who are desirous of eradicating the disease from their herds.

The following figures show the number of neat cattle quarantined by local inspectors, the number for which warrants were issued, and the disposition made of the animals: —

Total number of cattle quarantined or reported for examination during the year,			2,846
Massachusetts Cattle.			
Number released,	345		
Number condemned, killed and paid for,	1,383		
Number permit to kill, paid for,	105		
Number permit to kill, no award,	146		
Number permit to kill, to be paid for,	15		
Number died in quarantine, no award,	80		
Number condemned and killed, award waived by owner,	1		
Number condemned and killed, in process of settlement,	247		
Number in quarantine, unsettled,	30		
		2,352	
Cattle from without the State.			
Number released for slaughter,	9		
Number condemned and killed, no award,	469		
Number condemned, killed, no lesions found, paid for,	10		
Number condemned, killed, no lesions found, to be paid for,	5		
Number unsettled,	1		
		494	
Total,			2,846

Of the above 494 interstate cattle, 375 were tested at Brighton, 5 of which were released for slaughter and 370 condemned; no lesions were found in 9, for 7 of which the State has reimbursed the owners, and payment will be made for the remaining 2 upon presentation of claims by owners. Of the remaining 119 cattle (which were tested at other points than Brighton), 6 were found to show no lesions; for 3 of these the State has reimbursed the owners, and 3 will be paid for upon presentation of claims.

In addition to the 2,846 head of cattle disposed of as above, 302 cattle and 106 swine have been reported by butchers, renderers and boards of health as having been found tuberculous at the time of slaughter, all of which were rendered. Of this number, 92 cattle and 67 swine were slaughtered and condemned at the Brighton Abattoir.

The policy of the Bureau has been changed to some extent in the handling of cattle condemned because of tuberculosis. In view of the extremely high initial cost of dairy cattle it has seemed wise to at least attempt to meet the farmer with a price which would be of material assistance to him in replacing the condemned animal. The Bureau's agents do not lose sight of the fact that a cow badly affected with tuberculosis is not of especial value. However, they desire to encourage a spirit of co-operation on the part of the individual owner which will insure prompt report on his part of any suspicious animal that may be in his herd, and they endeavor to cause him to feel that in reporting the case to the Cattle Bureau, rather than calling in a local dealer, he is not only benefiting himself, but assisting in the work of eradication of the disease from the State.

Under the second group, the maintenance of a quarantine against other States to prevent the introduction of tuberculous cattle from outside sources into Massachusetts, the following figures show the number of animals brought in from without the State, and the disposition made of them: —

Receipts of Stock at the Watertown Stock Yards, from Dec. 1, 1910, to Nov. 30, 1911.

New Hampshire cattle,	5,268
Vermont cattle,	2,922
Massachusetts cattle,	1,456
Sheep and lambs,	1,366
Swine,	5,966
Calves,	23,660

Receipts of Stock at the New England Dressed Meat and Wool Company's Yards at Somerville, from Dec. 1, 1910, to Nov. 30, 1911.

New Hampshire cattle,	328
Vermont cattle,	2,354
Massachusetts cattle,	11
Western cattle,	22,994
Canada cattle,	21,382
Sheep and lambs,	429,205
Swine,	1,173,607
Calves,	34,903

Receipts of Stock at Brighton, from Dec. 1, 1910, to Nov. 30, 1911.

Maine cattle,	6,323
New Hampshire cattle,	2,958
Vermont cattle,	1,998
Massachusetts cattle,	11,183
New York cattle,	10,011
Western cattle,	64,889
Canada cattle,	887
Sheep and lambs,	17,366
Calves,	44,760
Swine,	94,202
Cattle tested,	14,023
Cattle condemned,	361
Cattle released after test,	13,662

The cattle upon which a tuberculin test is required are mostly milch cows to be offered for sale at the Brighton market Wednesdays, besides a few bulls and working oxen. Those animals that come to Watertown or Somerville are taken to Brighton, and all of the testing is done at the stock barn there.

Under the management of the agent now in charge of the quarantine station at Brighton, who was appointed on May 1,

1911, a most ideal condition for the handling of interstate cattle arriving there has been developed. The United States Bureau of Animal Industry, early in the summer, offered some suggestions relative to the manner of making the tuberculin test. As their formula did not seem to entirely fit the requirements of Massachusetts, a circular of instructions for making the tuberculin test was issued by the Bureau, having first received the endorsement of the officials at Washington. Copies of this circular were sent to all the agents of the Cattle Bureau, and the testing of cattle is now being done in a uniform manner throughout the State. The circular is as follows: —

COMMONWEALTH OF MASSACHUSETTS CATTLE BUREAU OF THE STATE BOARD OF AGRICULTURE.

Directions for making the Tuberculin Test.

Make a physical examination of each animal, and give to each one some designation by which it will be known throughout the test.

Take each animal's temperature at least twice at two-hour intervals on the day of injection.

Use only such tuberculin as is furnished or approved by this Bureau or the United States Bureau of Animal Industry.

If Bureau of Animal Industry tuberculin is used the dose is 2 cubic centimeters for an adult animal weighing about 750 pounds. Yearlings and two-year-olds, according to size, should receive from 1 to 1½ cubic centimeters, while bulls and very large animals may receive 3 cubic centimeters. Double or even triple doses should be given to cattle recently injected with tuberculin; also in the case of animals which, on physical examination, are suspected of being tuberculous.

Begin taking temperatures not later than ten hours after injection, and take them once in every two hours until the eighteenth hour is reached, at which time if there is no tendency for the temperature to rise the test may cease.

When other than normal conditions are noticed about an animal record should be made of the same.

When retests of suspicious animals are made use double the original dose. Begin taking temperatures not later than six hours after injection, taking at least five temperatures at intervals of two hours, at the expiration of which period if there is no tendency for the temperature to rise the test may cease.

Cattle tested within the limits of the State by order of the Chief of the Cattle Bureau, and those tested outside the State by Massa-

chusetts veterinarians for shipment into the State, should invariably be tagged, and the ear-tag number recorded on the certificate of test, unless there is some very special reason why this should not be done. It is also desired that veterinarians residing in other States testing cattle for shipment into this State should tag them. Massachusetts ear tags will be furnished to agents of the Cattle Bureau upon application.

Records of tuberculin tests should be complete, all information as required under the separate headings being filled in upon each chart.

Tuberculin tests made on cattle for shipment out of the State, to secure the endorsement of the Chief of the Cattle Bureau, must be made with tuberculin furnished or approved by this Bureau, and must be made in the way and manner prescribed above.

Inasmuch as certain States have individual requirements it is advisable for shippers to consult the Bureau for information before submitting to it tests on animals to be shipped into various States.

The attention of veterinarians is particularly called to the great importance of using special care and discretion in making tests on cattle to be shipped out of the State. Any evidence of a reliable nature furnished this Bureau to the effect that such work has not been performed in a thorough and professional manner will be deemed sufficient evidence for the discontinuance of employment by the Bureau of the veterinarian making the test.

FRED FREELAND WALKER,
Chief of Cattle Bureau.

BOSTON, July 25, 1911.

In accordance with the above instructions a new form of tuberculin test chart was adopted by the Bureau and is now in general use by Bureau agents.

On Aug. 1, 1911, an amendment to the civil service rules went into effect placing all veterinarians, or those doing similar work for the Commonwealth or the cities thereof, within the classified civil service. New appointees of this department are now selected from lists certified by the Civil Service Commission.

Very early in the fiscal year, namely, on Dec. 21, 1910, Cattle Bureau Order No. 28 was issued and approved by the Governor's Council on the same date. This order revoked Orders Nos. 16, 26 and 27, and amended Cattle Bureau Order No. 15, which latter order related to the shipment of cattle from other States into Massachusetts and the testing

of the same when necessary. The amendments are practically contained in one section of the new order, a copy of which section follows: —

Section 5 of Cattle Bureau Order No. 28.

All cattle, except those for immediate slaughter or calves under six months old, intended to be kept in the State permanently, must be tested with tuberculin either prior to shipment or after arrival at destination.

Certificates of tuberculin test made by qualified veterinarians residing in other States will be accepted, *provided* the test is made with tuberculin furnished or approved by State or federal government, and *provided also* that the certificates are *approved* and *endorsed* by the official in charge of live-stock interests in the State from which the cattle are shipped, or by his deputy.

The Chief of the Cattle Bureau may in his discretion retest any or all tested cattle brought within the limits of the Commonwealth from other States.

All tests made upon cattle after arrival within the limits of the Commonwealth must be made by agents of the Cattle Bureau, with tuberculin furnished by the Bureau. Such testing will be free of expense to citizens of Massachusetts, and at cost for other persons.

Cattle brought to the quarantine stations at Watertown, Brighton and Somerville, upon which a test is required, will be held and tested by the agent of the Cattle Bureau in charge of these stations, unless released by such agent on certificates of test approved and endorsed as hereinbefore described.

All cattle upon which a test is required, coming to points outside the limits of the quarantine stations, are to be held in quarantine at the risk and expense of the owner until released by order of the Chief of the Cattle Bureau.

Cattle returning from out-of-State pastures or boarding places, satisfactory as to sanitary conditions to the Chief of the Cattle Bureau, will not be subjected to a tuberculin test if they have not been out of the State over six months, *provided* they bear ear tags furnished for this purpose by the Massachusetts Cattle Bureau, the numbers of which have been forwarded to the office of the Bureau prior to the cattle being sent out of the State.

Cattle being returned to Massachusetts from without the State will not be considered as returning from out-of-State pastures unless they are returned to the farm of the person who originally sent them out of the State.

Cattle brought in from foreign countries, which have passed a test given by an agent of the United States Bureau of Animal Industry,

will be released upon arrival at destination without further test, and no certificates will be required.

Animals under control of the United States Bureau of Animal Industry, Department of Agriculture, intended for export, are not included in this order.

Animals believed to be diseased will be killed.

On June 12, 1911, Cattle Bureau Order No. 29 was issued, it being a renewal of previous orders prohibiting the bringing of cattle into certain pens and streets on the premises of the Butchers' Slaughtering and Melting Association at Brighton, except for the purpose of immediate slaughter, during the period between the date of issuance of the order and the first of November, 1911. This order was printed on large placards and posted on the quarantine grounds. The purpose of this order was to prevent the spread of contagion from any cattle which might be brought from districts infected with Texas fever during the summer months.

Report of Cattle brought into State during the Year to Points outside of the Quarantine Stations.

For dairy and breeding purposes, tested before shipment,	1,354
For dairy and breeding purposes, tested after arrival,	5,109
Total,	6,463
Neat cattle on which no test was required, exclusive of cattle and calves for immediate slaughter,	997

The cattle and calves on which no test was required, exclusive of animals for immediate slaughter, were as follows: —

Returned from out-of-State pastures,	768
Calves under six months old,	194
Died before test could be made,	2
Kept in State for brief periods only,	33
Total,	997

The number of cattle and calves brought into the State for immediate slaughter cannot be given exactly. In round numbers there were 10,000 cattle and calves brought to the

large abattoirs and other points outside the quarantine stations, intended for immediate slaughter.

Nearly all of the total number of animals given above were brought into the State on permits issued by the Chief of the Cattle Bureau, only 696 head having been brought in without permits, which were reported to the Bureau by railroad agents, local inspectors or others. Of these, 68 were tested before shipment, 9 were calves under six months old, 74 were slaughtered at once for beef, 206 were returned from pasture, 7 were in the State temporarily, and the remainder, 332 head, were tested by agents of the Cattle Bureau.

The following figures show the disposition of animals that were brought into the State to points outside the quarantine stations at Brighton, Watertown and Somerville, which failed to pass a satisfactory tuberculin test: —

Condemned on first test,	41
Condemned on second test,	68
Condemned on third test,	1
Died before a second test could be made,	1
Killed for beef on first test, subject to inspection,	1
Killed for beef on second test, subject to inspection,	4
Awaiting disposition,	2
Total,	118

Of the animals condemned as above, 2 are still awaiting slaughter; 2 were illegally disposed of before they could be killed; 6 were found on post-mortem examination to be free from disease, and either have been or will be paid for by the State; and 100 were found on post-mortem examination to be affected with tuberculosis. Of the 5 animals killed for beef after reacting, 4 were found diseased, and on one no report for result has been received.

There were 1,027 permits issued during the year, 167 of which were not used.

Twenty permits were issued allowing cattle to be brought into the State for the purpose of exhibition; 5 were issued for returning cattle from exhibition in other States; 11 were issued for pasturing herds in the State during the season;

5 allowing cattle to be unloaded in transit through the State; 5 allowing cattle to cross the line daily from pasture or farms in other States; and 2 allowing persons living near the line to drive cattle across the corner of the State, keeping the animals in the State for brief periods only.

Five herds were brought into the State for exhibition purposes unaccompanied by a permit, but were duly reported, and the cattle later returned to the States from which they came.

For several years, at the request of the United States Department of Commerce and Labor, a report of the receipts of all live stock at the port of Boston has been sent to Washington each month. The report is made to show weekly receipts. The following table shows the tables, by months, for the past year: —

Receipts of Live Stock at Boston for Twelve Months ending Nov. 30, 1911.

For Month ending —	Cattle.	Calves.	Sheep and Lambs.	Swine.	Horses.
December 27,	11,336	4,799	19,358	108,710	1,590
January 31,	11,498	7,408	30,622	149,930	2,124
February 28,	9,290	6,664	17,899	111,851	1,855
April 4,	12,984	9,918	24,443	133,591	2,205
May 2,	9,493	11,072	21,648	84,661	1,705
May 30,	13,503	10,270	27,946	92,743	1,842
July 4,	14,861	12,669	34,111	139,725	2,265
August 1,	11,453	8,122	36,929	91,607	1,813
August 30,	11,057	7,303	38,319	79,612	1,714
October 3,	17,355	9,115	55,267	89,151	2,203
October 31,	15,597	7,974	66,012	74,765	1,748
November 30,	16,535	7,639	75,383	116,429	1,620
Totals,	154,962	102,953	447,937	1,272,775	22,684

The third division of the work consists in testing herds with tuberculin for owners who desire it, and is known as *voluntary request work.* Comparatively little of this work has been undertaken during the past year, but the following figures show what has been done under this division: —

5 persons made voluntary requests to have their herds tested: —

5 herds were tested, comprising		57 cattle.
Released, ...	48	
Killed and paid for, ...	9	
	—	57 cattle.

Miscellaneous Diseases.

The Cattle Bureau is called upon during the year to deal with other diseases of a contagious nature, in addition to rabies, glanders and bovine tuberculosis, and these diseases are usually classified under the title of "miscellaneous diseases." Among them are actinomycosis, mange, hog cholera and allied troubles, symptomatic anthrax or blackleg, anthrax, Texas fever, and tuberculosis in other animals than cattle.

Hog cholera has occurred in 60 herds of swine, comprising 3,584 head, of which number 2,297 are reported as having died.

Five cases of actinomycosis have been reported, and in each case the animal has been slaughtered.

In pastures where symptomatic anthrax or blackleg occurred the previous season the protective inoculation has been given to the young animals when the owners requested it. The material used for this preventive inoculation, as in the past season, has been furnished by the United States Bureau of Animal Industry, and sent to Dr. James B. Paige of the Amherst Agricultural College, who has prepared it for use in the treatment when required. Two hundred and sixty-two head of young stock have been vaccinated by Dr. Paige and his brother, Dr. Henry E. Paige, and in nearly every instance a report from the owner at the end of ten days following the vaccination has been received, showing the efficiency of this method of prevention of the disease and the safety of the application of the treatment, for without exception the disease has been arrested almost immediately, and not a single case of death due to vaccination has been reported. The vaccine has been used in 50 herds, located in 20 different towns in various parts of the State, extending from Andover in Essex County to Rowe in Franklin County.

Under the provision of law classifying mange as a contagious disease the department has conducted quite extensive

work along the line of assisting owners to eradicate this disease from their premises, and has made an attempt to do this work with the least possible inconvenience to the owner. The Bureau has recommended certain easily prepared remedies, which have been applied by the owners of cattle and horses affected, and in practically every instance the treatment has resulted in the cure of the animals affected. Since the law went into effect, on May 1, 1911, the disease has been reported as occurring in 104 cow barns and in 26 horse barns. When it becomes generally known that mange is recognized as a contagious disease, the occurrence of which is to be reported to this department, I believe that, through the co-operation of this Bureau with the owners of animals affected, speedy and permanent eradication of the disease from the State will result.

Outbreaks of anthrax have been reported on 21 farms, and animals have been given preventive inoculation against this disease upon request of owners.

On Nov. 15, 1911, the following order was issued: —

CATTLE BUREAU ORDER No. 30.

THE COMMONWEALTH OF MASSACHUSETTS,
CATTLE BUREAU OF THE STATE BOARD OF AGRICULTURE,
BOSTON, Nov. 15, 1911.

To all Persons whom it may concern.

Section 1, Chapter 381, Acts of 1911, provides as follows: —

SECTION 1. The chief of the cattle bureau and his agents are hereby authorized to enter and inspect all barns, stables, pastures, yards and other places where neat cattle, other ruminants, or swine are kept. The chief of the cattle bureau may make and enforce all reasonable rules and regulations respecting the sanitary condition of such barns, stables and other places, and of the neat cattle, other ruminants and swine kept therein, such rules and regulations to be subject to approval by the governor and council.

By virtue of the power and authority vested in the Cattle Bureau of the State Board of Agriculture, under the provisions of the foregoing section, you are hereby notified that this Bureau issues the following order: —

1. Owners or tenants of barns, stables, pastures, yards and other places where neat cattle, other ruminants or swine are kept are required to provide, to the satisfaction of the Chief of the Cattle Bureau or his duly authorized agents, as follows: —

Proper ventilation,
Proper space for stabling,
Sufficient light,
Proper drainage,
Proper disinfection of premises,
Wholesome water supply and proper distribution of same to cattle,
Proper disposal of excrement, and
General cleanliness.

2. Any person failing to comply with directions emanating under section 1 of this order shall be punished as provided in section 29 of chapter 90 of the Revised Laws.

3. This order shall be published by sending a copy to each inspector of animals in the Commonwealth, and by general distribution to farmers and cattle owners.

This order shall take effect upon its approval.

FRED FREELAND WALKER,
Chief of Cattle Bureau.

Approved in Council, Nov. 15, 1911.
EDWARD F. HAMLIN,
Executive Secretary.

FINANCIAL STATEMENT.

At the close of the last fiscal year, Nov. 30, 1910, there was on hand, as per the eighteenth semiannual report: —

Balance of appropriation for salaries and expenses for 1910,	$401 61	
Balance of appropriation for general work of the Bureau for 1910,	10,052 09	
		$10,453 70
Appropriation for salaries and expenses of 1911, chapter 714, Acts of 1911,	$7,500 00	
Appropriation for general work of the Bureau, chapter 715, Acts of 1911,	100,000 00	
Additional appropriation for general work of the Bureau, chapter 749, Acts of 1911,	5,000 00	
		112,500 00
Total to be accounted for,		$122,953 70

Expended during the year: —

For 217 head of cattle condemned and killed during the year 1910, paid for in 1911,	$5,163 50	

For 1,553 head of cattle condemned and killed during the year, . . .	$40,561 35	
For killing and burial, quarantine claims and arbitration expenses, . . .	193 40	
		$45,918 25
For services of agents (exclusive of glanders work), account of 1910, .	$51 00	
For services of agents (exclusive of glanders work), account of 1911, .	14,432 76	
For expenses of agents (exclusive of glanders work), account of 1910, .	18 00	
For expenses of agents (exclusive of glanders work), account of 1911, .	5,632 85	
For expenses of quarantine stations, account of 1910, ...	1 00	
For expenses of quarantine stations, account of 1911, ...	5,848 36	
For expenses of glanders work, including services and expenses of agents, laboratory work and killing and burial, account of 1910, . . .	12 00	
For expenses of glanders work, including services and expenses of agents, laboratory work and killing and burial, account of 1911, . . .	7,334 52	
For laboratory expenses (exclusive of glanders work), ...	1,005 92	
For implements, ear tags, thermometers, etc., ...	819 58	
For salary of Chief of Bureau, . .	1,800 00	
For salary of clerk, ...	1,190 00	
For salaries of assistant clerks and stenographers, ...	1,942 50	
For office expenses, printing, postage, stationery, etc., account of 1910, .	68 53	
For office expenses, printing, postage, stationery, etc., account of 1911, .	1,948 46	
For expenses of Chief of Bureau, account of 1910, ...	64 23	
For expenses of Chief of Bureau, account of 1911, ...	251 86	
		42,421 57
Total expenditures, ...		$88,339 82
Balance from all accounts, Nov. 30, 1911, . . .		34,613 88
Total as above, ...		$122,953 70

This balance is made up from the following items: —

Balance of appropriation for salaries and expenses, 1910, ...	$268 85
Balance of appropriation for salaries and expenses, 1911, ...	367 18
Balance of appropriation for general work of the Bureau, 1910, ...	4,806 59
Balance of appropriation for general work of the Bureau, available for unsettled accounts of 1911, . .	29,171 26
	$34,613 88

The average price paid for condemned cattle for the year was $25.83.

There has been received during the year from the sale of hides and carcasses of condemned animals, sale of ear tags, testing cattle for nonresident owners, etc., $4,519.83.

Claims for 271 head of cattle condemned and killed as tuberculous during the year remained unsettled, to be paid for on proof of claims, the appraised value of which amounts to $6.323.52.

Twenty-one stamps for branding carcasses of animals killed and inspected for food have been furnished to 20 cities and towns during the year.

Under chapter 297 of the Acts of 1911, approved April 20, the furnishing of these branding stamps was placed in charge of the State Board of Health.

Respectfully submitted,

FRED FREELAND WALKER,
Chief of Cattle Bureau.

FINANCIAL RETURNS

AND

ANALYSIS OF PREMIUMS AND GRATUITIES

OF THE

INCORPORATED SOCIETIES,

WITH

MEMBERSHIP AND INSTITUTES,

FOR THE YEAR 1911.

FINANCIAL RETURNS OF THE INCORPORATED

	SOCIETIES.	When incorporated.	Amount originally raised by Contribution. (R. L. 124, Sects. 1 and 3.)	Amount now held invested as Capital Stock. (R. L. 124, Sects. 3 and 12.)	Estimated Market Value of Property.	Total Assets.
1	Amesbury and Salisbury (Agricultural and Horticultural),	1881	$1,002 32	[1] $8,121 97	$8,121 97	$8,121 97
2	Barnstable County,	1844	1,740 00	[2] 9,987 31	9,987 31	10,438 89
3	Blackstone Valley,	1884	3,000 00	[3] 7,500 00	7,500 00	7,539 97
4	Deerfield Valley,	1871	4,094 01	[1] 9,750 00	9,750 00	9,750 00
5	Eastern Hampden,	1856	3,000 00	[3] 19,300 00	19,300 00	19,372 98
6	Essex,	1818	4,527 20	[4] 15,758 89	15,758 89	15,758 89
7	Franklin County,	1850	3,768 00	[4] 11,270 74	11,270 74	11,270 74
8	Hampshire,	1850	3,255 26	[5] 5,161 71	5,161 71	5,161 71
9	Hampshire, Franklin and Hampden,	1818	8,141 29	[6] 24,741 40	24,741 40	24,741 40
10	Highland,	1859	3,262 00	[1] 3,120 00	3,120 00	3,242 65
11	Hillside,	1883	3,113 32	[6] 5,922 05	5,922 05	5,922 05
12	Hingham (Agricultural and Horticultural),	1867	17,406 15	[6] 4,692 72	4,692 72	4,692 72
13	Hoosac Valley,	1860	2,006 00	[3] 15,000 00	15,000 00	16,161 00
14	Housatonic,	1848	6,335 33	[4] 27,292 20	27,292 20	27,292 20
15	Lenox Horticultural,	1910	1,000 00	[6] 2,914 18	2,914 18	2,914 18
16	Marshfield (Agricultural and Horticultural),	1867	3,755 33	[1] 13,000 00	13,000 00	13,480 75
17	Martha's Vineyard,	1859	4,552 17	[7] 4,985 47	4,985 47	5,082 83
18	Massachusetts Horticultural,	1829	525 00	[8] $46,100 10	$46,100 10	$56,845 17
19	Massachusetts Society for Promoting Agriculture,[9]	1792	–	–	–	–
20	Middlesex North,	1855	3,000 00	[10] 7,300 12	7,300 12	7,300 12
21	Middlesex South,	1854	3,000 00	[1] 12,200 00	12,200 00	12,200 60
22	Nantucket,	1856	3,500 00	[3] 3,200 00	3,200 00	3,383 80
23	Oxford,	1888	4,400 00	[6] 11,636 47	11,636 47	11,636 47
24	Plymouth County,	1819	9,550 00	[11] 2,193 88	2,198 88	2,198 88
25	Spencer (Farmers' and Mechanics' Association),	1888	4,034 00	[1] 10,350 00	10,350 00	10,424 66
26	Union (Agricultural and Horticultural),	1867	4,447 23	[1] 9,000 00	9,000 00	9,349 05
27	Weymouth (Agricultural and Industrial),	1891	10,270 00	[1] 11,270 00	11,270 00	11,299 51
28	Worcester,	1818	7,730 00	[6] 99,130 97	99,130 97	99,130 97
29	Worcester East,	1890	2,296 23	[1] 12,491 30	12,491 30	12,688 02
30	Worcester North (Agricultural and Driving Association),	1852	3,602 63	[6] 3,602 63	3,602 63	3,602 63
31	Worcester Northwest (Agricultural and Mechanical),	1867	3,400 00	[12] 13,801 61	13,801 61	13,801 61
32	Worcester South,	1855	3,127 40	[5] 12,883 00	12,883 00	12,883 75
33	Worcester County West,	1851	3,175 00	[1] 10,500 00	10,500 00	10,547 39
			$140,015 87	$1,254,183 72	$1,254,183 72	$1,268,237 56

[1] Invested in real estate, crockery, tables, etc.

[2] Invested in real estate and bank funds.

[3] Invested in real estate.

[4] Invested in real estate, stocks, bank funds, crockery, tables, etc.

[5] Invested in real estate, bank funds, crockery, tables, etc.

[6] Invested in bank funds, crockery, tables, etc.

SOCIETIES FOR THE YEAR ENDING DEC. 31, 1911.

Real Estate.	Notes.	Stocks and Bonds.	Bank Funds.	Bills due and unpaid.	Crockery, Tables, etc.	Cash on Hand.	Total Liabilities.	
$7,716 69	-	-	-	-	$405 28	-	$1,716 49	1
8,000 00	-	-	$1,987 31	$55 00	-	$396 58	5,919 60	2
7,500 00	-	-	-	-	-	39 97	2,822 50	3
9,500 00	-	-	-	-	250 00	-	570 28	4
19,300 00	-	-	-	10 00	-	62 98	8,814 75	5
15,300 00	-	$180 00	-	-	200 00	78 89	10,500 00	6
10,000 00	-	1,000 00	20 74	-	250 00	-	2,452 86	7
5,000 00	-	-	-	-	50 00	111 71	1,778 00	8
23,810 00	-	-	-	-	800 00	131 40	5,910 40	9
3,000 00	-	-	-	77 25	120 00	45 40	129 30	10
5,000 00	-	-	572 05	-	350 00	-	-	11
2,500 00	-	-	1,292 72	-	900 00	-	-	12
15,000 00	-	-	-	-	-	1,161 00	9,000 00	13
24,849 37	-	500 00	928 20	-	425 00	589 63	2,050 00	14
-	-	-	2,564 18	-	350 00	-	-	15
12,500 00	-	-	-	30 00	500 00	-	14 45	16
2,750 00	$100 00	-	1,935 47	19 00	200 00	78 36	40 00	17
518,564 63	-	272,925 00	-	-	9,500 00	10,745 07	-	18
-	-	-	-	-	-	-	-	19
-	4,124 00	-	3,146 89	-	-	29 23	69 00	20
12,000 00	-	-	-	-	200 00	60	10,423 20	21
3,200 00	-	-	-	-	-	183 80	-	22
11,000 00	-	-	3 87	-	632 60	-	2,500 00	23
-	-	-	2,157 32	-	39 00	2 56	-	24
9,400 00	-	-	-	17 50	950 00	57 16	1,839 00	25
8,000 00	-	-	-	-	1,000 00	349 05	1,111 25	26
11,000 00	-	-	-	-	270 00	29 51	4,275 00	27
81,947 22	-	-	15,245 39	-	1,938 36	-	-	28
11,534 00	-	-	196 72	-	957 30	-	-	29
-	-	-	3,194 29	-	408 34	-	-	30
13,000 00	-	-	501 61	-	300 00	-	3,050 00	31
12,000 00	-	-	-	-	700 00	183 75	1,487 20	32
10,000 00	-	-	-	-	500 00	47 39	1,050 22	33
$873,371 91	$4,224 00	$274,605 00	$33,746 76	$208 75	$22,195 88	$14,324 04	$77,523 50	

[7] Invested in real estate, notes, bank funds, crockery, tables, etc.

[8] Invested in real estate, library, stocks, bonds, crockery, tables and furniture.

[9] Represented on the Board by special enactment, and makes no returns.

[10] Invested in notes, cash and bank funds.

[11] Invested in cash, bank funds, crockery, tables, etc.

[12] Invested in real estate, bonds, crockery, tables, etc.

Financial Returns of the Incorporated Societies

	SOCIETIES.	Premiums due and unpaid.	Outstanding Bills.	Mortgages or Like Liabilities.	Total Receipts.	Bounty.	Income from Notes and Bank Funds.
1	Amesbury and Salisbury (Agricultural and Horticultural),	-	[1] $216 49	$1,500 00	$2,841 44	$600 00	-
2	Barnstable County,	$219 60	100 00	5,600 00	5,457 72	600 00	$40 00
3	Blackstone Valley,	-	187 50	2,635 00	6,348 21	600 00	2,100 00
4	Deerfield Valley,	-	70 28	500 00	2,943 79	600 00	-
5	Eastern Hampden,	-	1,254 75	7,560 00	7,528 53	600 00	-
6	Essex,	-	-	10,500 00	2,803 47	528 50	2 78
7	Franklin County,	-	152 86	2,300 00	8,441 71	600 00	-
8	Hampshire,	25 00	3 00	1,750 00	3,288 72	600 00	-
9	Hampshire, Franklin and Hampden,	110 40	-	5,800 00	13,823 90	600 00	24 49
10	Highland,	30	4 00	[1] 125 00	1,248 56	600 00	-
11	Hillside,	-	-	-	1,584 20	600 00	17 54
12	Hingham (Agricultural and Horticultural),	-	-	-	891 87	600 00	49 52
13	Hoosac Valley,	-	9,000 00	-	7,233 00	600 00	-
14	Housatonic,	-	50 00	2,000 00	12,139 05	600 00	18 20
15	Lenox Horticultural,	-	-	-	863 00	528 50	50 50
16	Marshfield (Agricultural and Horticultural),	14 45	-	-	9,773 03	600 00	-
17	Martha's Vineyard,	-	[4] 40 00	-	1,065 88	600 00	88 00
18	Massachusetts Horticultural,	-	-	-	25,040 06	600 00	-
19	Massachusetts Society for Promoting Agriculture,[3]	-	-	-	-	-	-
20	Middlesex North,	69 00	-	-	758 58	466 40	289 18
21	Middlesex South,	263 75	509 45	9,650 00	5,263 90	600 00	-
22	Nantucket,	-	-	-	1,661 33	600 00	-
23	Oxford,	-	-	2,500 00	4,063 29	600 00	-
24	Plymouth County,	-	-	-	625 95	426 50	105 77
25	Spencer (Farmers' and Mechanics' Association),	-	39 00	1,800 00	3,013 51	544 47	-
26	Union (Agricultural and Horticultural),	11 25	-	1,100 00	2,733 33	600 00	-
27	Weymouth (Agricultural and Industrial),	-	175 00	4,100 00	4,017 69	600 00	-
28	Worcester,	-	-	-	40,563 78	600 00	596 90
29	Worcester East,	-	-	-	13,797 84	600 00	-
30	Worcester North (Agricultural and Driving Association),	-	-	-	6,517 87	-	48 48
31	Worcester Northwest (Agricultural and Mechanical),	-	-	3,050 00	7,101 48	600 00	-
32	Worcester South,	47 45	39 75	1,400 00	8,729 08	600 00	-
33	Worcester County West,	215 20	185 02	[1] 650 00	3,547 53	600 00	-
		$976 40	$12,027 10	$64,520 00	$215,711 30	$18,094 37	$3,431 36

[1] Notes. [2] Includes loan of $500. [3] Not reported. [4] Estimated.

FOR THE YEAR ENDING DEC. 31, 1911 — *Concluded.*

Income from Stocks and Bonds.	Received from New Members.	Received as Donations.	Received from All Other Sources.	Total Expenditures.	Premiums and Gratuities paid.	Current Running Expenses.	Interest.	All Other Expenses.	
–	$21 00	–	$2,220 44	$3,057 93	$714 31	–	$75 00	$2,268 62	1
–	150 00	$104 30	4,563 42	10,661 14	1,019 75	$5,582 29	317 50	3,741 60	2
–	24 00	95 54	3,526 67	6,308 24	736 86	2,084 63	65 00	3,421 75	3
–	55 00	13 60	2,275 19	2,943 79	1,309 70	984 09	–	650 00	4
–	86 00	–	6,842 53	7,490 50	968 31	6,207 29	314 90	–	5
$180 00	9 00	[2] 556 50	1,526 69	3,014 74	428 00	451 77	536 08	1,598 89	6
40 00	–	–	7,801 71	8,466 07	2,732 10	4,921 50	174 97	637 50	7
–	34 75	101 12	2,552 85	2,683 01	627 40	424 14	139 42	1,492 05	8
–	75 00	–	13,724 41	13,823 90	3,514 00	6,189 23	292 50	3,828 17	9
–	55 00	–	593 56	1,200 94	654 05	546 89	–	–	10
–	72 00	10 00	884 66	[3] –	[3] –	[3] –	[3] –	[3] –	11
–	55 00	18 60	168 75	920 03	619 60	300 43	–	–	12
–	–	–	6,633 00	5,472 00	2,578 00	1,028 00	450 00	1,416 00	13
26 25	412 00	–	11,082 60	11,900 89	4,338 25	6,039 54	100 00	1,423 10	14
–	59 00	225 00	–	939 42	548 50	390 92	–	–	15
–	70 00	75 00	9,028 03	9,322 28	1,645 32	6,042 55	28 32	1,606 09	16
–	–	–	377 88	1,091 30	606 30	[4] 325 00	–	160 00	17
11,836 11	420 00	722 29	11,461 75	21,175 51	5,256 50	–	–	15,919 01	18
–	–	–	–	–	–	–	–	–	19
–	3 00	–	–	1,042 80	663 95	250 54	–	128 31	20
–	25 00	341 50	4,297 40	5,263 30	1,806 12	1,085 75	555 42	1,816 01	21
–	22 00	41 75	997 58	1,476 01	618 75	857 29	–	–	22
–	30 00	25 73	3,407 56	4,063 29	970 72	1,494 02	127 15	1,471 40	23
–	–	–	520 18	455 05	401 70	53 35	–	–	24
–	8 00	51 25	2,409 79	2,956 35	1,745 45	977 90	233 00	–	25
–	41 00	–	2,092 33	2,384 28	1,044 44	868 55	204 91	266 38	26
–	–	33 60	3,384 09	3,389 09	580 15	2,398 94	175 00	235 00	27
–	230 00	350 00	38,786 88	42,505 17	8,505 33	–	–	33,999 84	28
–	53 00	4,053 00	9,091 84	14,229 38	3,075 20	9,557 55	–	1,596 63	29
–	[6] 325 00	–	6,144 39	4,615 57	413 99	–	–	4,201 58	30
–	–	–	6,501 48	8,481 48	1,820 00	6,478 48	183 00	–	31
–	60 00	–	8,069 08	8,506 54	2,637 86	5,163 14	77 75	627 79	32
–	5 00	25 00	2,917 53	2,900 14	1,404 40	1,456 74	39 00	–	33
$12,082 36	$2,399 75	$6,843 69	$173,881 27	$212,740 17	$53,985 01	$72,160 52	$4,088 92	$82,505 72	

[5] Represented on the Board by special enactment, and makes no returns. [6] All members.

ANALYSIS OF PREMIUMS AND GRATUITIES, MEMBERSHIP AND

	SOCIETIES.	Total Amount offered in Premiums.	Total Amount awarded in Premiums and Gratuities.	Total Amount paid in Premiums and Gratuities.	Amount offered under Head of Farms, etc.	Amount awarded under Head of Farms, etc.	Amount paid under Head of Farms, etc.	Amount offered under Head of Farm and Pet Stock.
1	Amesbury and Salisbury (Agricultural and Horticultural),	[1] –	[1] –	$714 31	–	–	–	[1] –
2	Barnstable County,	$2,438 25	$1,239 35	1,019 75	$124 00	–	–	$1,164 00
3	Blackstone Valley,	[1] –	895 05	736 86	145 00	$56 00	$56 00	733 50
4	Deerfield Valley,	1,189 75	1,323 30	1,309 70	–	–	–	920 00
5	Eastern Hampden,	1,205 75	968 36	968 36	98 00	–	–	550 00
6	Essex,	[1] –	733 25	428 00	37 00	10 00	–	602 00
7	Franklin County,	2,732 10	2,732 10	2,732 10	–	–	–	2,500 00
8	Hampshire,	1,795 25	646 40	621 40	10 00	8 00	8 00	1,193 00
9	Hampshire, Franklin and Hampden,	3,624 40	3,624 40	3,514 00	–	–	–	1,512 50
10	Highland,	737 00	654 35	654 05	–	–	–	430 50
11	Hillside,	974 80	1,000 80	1,000 80	–	–	–	650 00
12	Hingham (Agricultural and Horticultural),	1,377 60	619 60	619 60	71 75	–	–	–
13	Hoosac Valley,	2,578 00	2,578 00	2,578 00	–	–	–	1,147 50
14	Housatonic,	[1] –	4,338 25	4,338 25	100 00	100 00	100 00	2,044 00
15	Lenox Horticultural,	740 50	[1] –	548 50	50 00	–	–	–
16	Marshfield (Agricultural and Horticultural),	2,616 40	1,659 77	1,645 32	100 00	–	–	505 00
17	Martha's Vineyard,	654 00	606 30	606 30	–	–	–	438 25
18	Massachusetts Horticultural,	5,500 00	[1] –	5,256 50	[2] 283 00	[2] 288 50	[2] 288 50	–
19	Massachusetts Society for Promoting Agriculture,[3]	–	–	–	–	–	–	–
20	Middlesex North,	752 75	732 95	663 95	–	–	–	328 00
21	Middlesex South,	3,107 60	2,067 87	1,806 12	225 00	12 50	12 50	709 00
22	Nantucket,	1,200 00	[1] –	618 75	166 00	9 00	9 00	572 00
23	Oxford,	1,456 25	996 45	970 72	78 00	43 00	43 00	1,243 00
24	Plymouth County,	394 35	401 70	401 70	10 00	10 00	10 00	103 00
25	Spencer (Farmers' and Mechanics' Association),	2,200 00	1,780 45	1,745 45	–	–	–	818 50
26	Union (Agricultural and Horticultural),	1,641 60	1,055 69	1,044 44	–	–	–	804 00
27	Weymouth (Agricultural and Industrial),	1,105 00	613 75	580 15	–	–	–	679 00
28	Worcester,	[1] –	8,505 33	8,505 33	–	–	–	6,325 50
29	Worcester East,	3,400 00	3,075 20	3,075 20	32 00	30 00	30 00	1,786 50
30	Worcester North (Agricultural and Driving Association),	413 99	413 99	413 99	–	–	–	[1] –
31	Worcester Northwest (Agricultural and Mechanical),	[1] –	1,835 60	1,820 00	–	–	–	[1] –
32	Worcester South,	3,610 50	2,637 80	2,590 55	127 00	44 00	44 00	1,075 00
33	Worcester County West,	1,619 60	1,619 60	1,404 40	54 00	24 00	24 00	899 50
		$49,065 44	$49,355 66	$54,932 55	$1,710 75	$635 00	$625 00	$29,733 25

[1] Not reported. [2] Gardens.

INSTITUTES FOR THE YEAR ENDING DEC. 31, 1911.

Amount awarded under Head of Farm and Pet Stock.	Amount paid under Head of Farm and Pet Stock.	Amount offered under Head of Field and Garden Crops.	Amount awarded under Head of Field and Garden Crops.	Amount paid under Head of Field and Garden Crops.	Amount offered under Head of Farm and Garden Products.	Amount awarded under Head of Farm and Garden Products.	Amount paid under Head of Farm and Garden Products.	Amount offered under Head of Dairy Products.	Amount awarded under Head of Dairy Products.	
$282 10	$282 10	–	–	–	[1] –	$214 30	$204 30	[1] –	$3 25	1
489 00	356 00	$150 00	–	–	$548 50	355 50	312 40	$10 00	8 00	2
636 00	584 00	–	–	–	115 40	95 10	30 51	10 00	3 00	3
650 75	638 75	–	–	–	78 50	76 30	74 73	12 00	6 00	4
710 00	710 00	–	–	–	82 25	155 00	155 00	32 00	25 00	5
309 50	146 50	205 00	$17 00	$10 00	419 50	264 50	226 50	14 00	7 00	6
1,254 50	1,254 50	–	–	–	500 00	190 65	190 65	21 00	11 00	7
388 00	388 00	25 00	23 00	23 00	266 75	103 50	78 50	6 00	1 50	8
1,215 25	1,135 75	65 00	–	–	265 75	229 70	228 40	36 00	16 00	9
429 80	429 80	18 00	12 00	12 00	70 00	47 85	47 85	5 00	5 00	10
649 80	649 80	50 00	51 75	51 75	87 00	77 70	77 70	4 00	2 00	11
–	–	175 00	45 00	45 00	776 40	378 00	378 00	3 75	3 75	12
260 00	260 00	–	–	–	138 50	112 00	112 00	18 00	8 50	13
1,195 00	1,195 00	282 00	271 00	271 00	391 50	272 50	272 50	38 00	38 00	14
–	–	–	–	–	740 50	548 50	548 50	–	–	15
366 67	363 17	90 50	5 00	5 00	252 00	194 45	192 55	17 50	6 50	16
271 35	271 35	–	–	–	114 25	107 35	107 35	10 00	7 00	17
–	–	–	–	–	6,362 50	5,112 00	5,112 00	–	–	18
–	–	–	–	–	–	–	–	–	–	19
389 75	355 00	–	–	–	322 75	269 50	241 00	–	–	20
248 50	248 50	[4] 50 00	–	–	525 00	259 25	259 25	60 00	6 00	21
287 00	287 00	134 00	46 75	46 75	89 25	36 00	36 00	16 00	–	22
764 50	742 65	65 50	58 00	58 00	179 50	111 50	110 00	9 00	2 00	23
107 00	107 00	–	–	–	164 75	146 85	146 85	–	–	24
441 75	441 75	52 00	44 25	44 25	105 00	67 25	62 50	10 00	7 00	25
410 00	404 50	–	–	–	72 35	37 45	36 70	13 25	8 75	26
323 55	325 55	–	–	–	210 00	114 90	105 50	5 50	60	27
3,827 25	3,827 25	–	–	–	517 00	424 00	424 00	22 00	5 00	28
1,397 65	1,397 65	100 00	100 00	100 00	1,116 10	1,026 50	1,026 50	21 00	5 00	29
[1] –	234 80	–	–	–	[1] –	[1] –	38 20	–	–	30
1,131 50	1,127 50	–	–	–	[1] –	580 25	572 25	[1] –	6 00	31
800 00	719 00	–	–	–	229 50	165 30	162 90	18 00	10 00	32
573 20	421 85	–	–	–	190 50	127 25	90 25	14 00	9 00	33
$19,809 37	$19,304 72	$1,462 00	$673 75	$666 75	$14,931 00	$11,900 90	$11,661 34	$426 00	$210 85	

[3] Represented on the Board by special enactment, and makes no returns. [4] Silver bronze.

ANALYSIS OF PREMIUMS AND GRATUITIES, MEMBERSHIP AND

	SOCIETIES.	Amount paid under Head of Dairy Products.	Amount offered under Head of Domestic Manufactures.	Amount awarded under Head of Domestic Manufactures.	Amount paid under Head of Domestic Manufactures.	Amount offered under Head of Miscellaneous.	Amount awarded under Head of Miscellaneous.	Amount paid under Head of Miscellaneous.
1	Amesbury and Salisbury (Agricultural and Horticultural),	$3 25	[1] –	$84 55	$79 55	[1] –	$109 81	$102 81
2	Barnstable County,	8 00	$307 75	301 95	265 90	$144 00	84 90	77 45
3	Blackstone Valley,	3 00	107 25	39 25	36 25	[1] –	27 10	27 10
4	Deerfield Valley,	6 00	99 50	86 50	86 50	79 75	38 75	38 75
5	Eastern Hampden,	25 00	70 50	61 35	61 35	45 00	20 00	20 00
6	Essex,	6 00	32 00	20 00	7 00	225 00	121 00	107 00
7	Franklin County,	11 00	200 00	90 45	90 45	–	–	–
8	Hampshire,	1 50	42 00	39 75	39 75	32 50	32 50	32 50
9	Hampshire, Franklin and Hampden,	16 00	85 50	55 00	53 70	89 50	68 20	65 50
10	Highland,	5 00	72 00	65 70	65 70	29 00	[1] –	24 00
11	Hillside,	2 00	100 00	94 15	94 15	[1] –	62 70	62 70
12	Hingham (Agricultural and Horticultural),	3 75	174 75	143 75	143 75	176 00	49 10	49 10
13	Hoosac Valley,	8 50	218 25	153 20	153 20	51 00	21 50	21 50
14	Housatonic,	38 00	712 75	415 75	415 75	[1] –	125 25	125 25
15	Lenox Horticultural,	–	–	–	–	–	–	–
16	Marshfield (Agricultural and Horticultural),	6 50	146 00	149 25	146 25	70 00	87 90	84 35
17	Martha's Vineyard,	7 00	77 00	115 45	115 45	10 00	24 25	29 30
18	Massachusetts Horticultural,	–	–	–	–	–	–	–
19	Massachusetts Society for Promoting Agriculture,[1]	–	–	–	–	–	–	–
20	Middlesex North,	–	82 00	58 00	52 25	20 00	15 70	15 70
21	Middlesex South,	6 00	200 00	49 50	49 50	–	–	–
22	Nantucket,	–	114 50	86 75	86 75	99 50	127 25	127 25
23	Oxford,	2 00	121 50	82 95	82 95	–	–	–
24	Plymouth County,	–	39 50	42 75	42 75	77 00	95 00	95 00
25	Spencer (Farmers' and Mechanics' Association),	7 00	52 00	29 50	22 00	[1] –	17 95	17 95
26	Union (Agricultural and Horticultural),	8 75	139 70	110 22	105 49	[1] –	117 25	117 00
27	Weymouth (Agricultural and Industrial),	60	165 15	84 40	80 00	[1] –	39 10	39 10
28	Worcester,	5 00	188 75	127 50	127 50	[1] –	50 00	50 00
29	Worcester East,	5 00	471 90	225 30	225 30	300 00	287 75	290 75
30	Worcester North (Agricultural and Driving Association),	–	–	–	–	–	–	–
31	Worcester Northwest (Agricultural and Mechanical),	6 00	[1] –	82 10	[1] –	[1] –	32 15	32 15
32	Worcester South,	10 00	95 25	77 40	77 40	71 25	68 75	68 75
33	Worcester County West,	9 00	69 80	55 65	40 80	[1] –	23 00	12 00
		$209 85	$4,185 30	$3,028 07	$2,847 39	$1,519 50	$1,746 86	1,732 96

[1] Not reported. [2] And gratuities. [3] Estimated.

INSTITUTES FOR THE YEAR ENDING DEC. 31, 1911 — *Concluded.*

Amount paid for Trotting.	Number of Persons receiving Premiums.	Number of Persons receiving Gratuities.	Number of Cities and Towns where Premiums were paid.	Amount paid to Parties outside the State.	Number of Male Members.	Number of Female Members.	Total Membership.	Number of Institute Sessions held.	Average Attendance per Session.	
–	[2] 245	–	15	$80 75	402	41	443	8	69	1
$408 00	131	183	14	–	219	176	395	3	93	2
280 00	147	12	13	–	252	223	475	5	87	3
465 00	[3] 200	–	23	24 65	957	260	1,217	8	150	4
2,065 00	[2] 127	–	23	25 50	265	179	444	2	88	5
–	194	29	21	–	806	24	830	7	110	6
1,065 00	[1] –	[1] –	16	–	1,400	100	1,500	5	180	7
427 50	179	–	9	–	[1] –	[1] –	615	4	66	8
1,113 00	[2] 260	–	27	–	680	250	930	3	70	9
70 00	169	–	16	–	243	123	366	3	70	10
55 00	[3] 300	–	15	–	915	52	967	7	111	11
–	96	217	6	–	352	140	492	3	188	12
970 00	135	3	10	94 75	376	15	391	2	43	13
1,870 00	503	–	22	208 75	1,764	81	1,845	6	98	14
–	30	–	5	9 50	130	18	148	3	62	15
850 00	110	215	29	30	525	299	824	6	67	16
–	[1] –	[1] –	6	–	74	75	149	3	57	17
–	125	61	72	130 50	704	132	836	8	294	18
–	–	–	–	–	–	–	–	–	–	19
–	269	25	18	–	501	218	719	12	194	20
800 00	108	72	15	–	324	293	617	3	81	21
115 00	92	63	1	–	216	413	629	3	24	22
1,100 00	138	9	17	–	337	279	616	4	54	23
–	[2] 132	–	11	–	610	512	1,122	8	81	24
1,150 00	125	9	17	–	414	413	827	6	127	25
372 00	124	76	18	2 13	673	858	1,531	3	248	26
613 50	[1] –	[1] –	13	–	480	10	490	3	65	27
3,400 00	386	55	76	1,075 00	1,545	231	1,776	5	123	28
–	337	105	35	–	122	109	231	5	85	29
2,350 00	524	–	[1] –	[1] –	70	–	70	–	–	30
1,225 00	[1] –	[1] –	36	7 00	[1] –	[1] –	[1] –	6	77	31
1,500 00	122	72	27	249 50	672	582	1,254	6	76	32
807 50	164	51	25	149 00	385	76	461	4	50	33
$23,071 50	5,472	1,257	651	$2,057 33	16,413	6,182	23,210	154	[5] 12.84	

[4] Represented on the Board by special enactment, and makes no returns.

[5] General average of attendance.

DIRECTORY

OF THE

Agricultural and Similar Organizations of Massachusetts.

1912.

State Board of Agriculture, 1912.

Members ex Officio.

His Excellency EUGENE N. FOSS.
His Honor ROBERT LUCE.
Hon. ALBERT P. LANGTRY, *Secretary of the Commonwealth.*
KENYON L. BUTTERFIELD, LL.D., *President Massachusetts Agricultural College.*
FREDERICK F. WALKER, *Chief of the Cattle Bureau.*
F. WM. RANE, B. Agr., M.S., *State Forester.*
J. LEWIS ELLSWORTH, *Secretary of the Board.*

Members appointed by the Governor and Council.

	Term expires
CHARLES M. GARDNER of Westfield,	1913
FRANK P. NEWKIRK of Easthampton,	1914
HENRY M. HOWARD of West Newton,	1915

Members chosen by the Incorporated Societies.

Amesbury and Salisbury (Agricultural and Horticultural),	A. WILLIS BARTLETT of Salisbury,	1915
Barnstable County,	JOHN BURSLEY of West Barnstable,	1913
Blackstone Valley,	JACOB A. WILLIAMS of Northbridge,	1915
Deerfield Valley,	ERNEST W. PAYNE of Heath,	1914
Eastern Hampden,	O. E. BRADWAY of Monson,	1915
Essex,	FREDERICK A. RUSSELL of Methuen,	1914
Franklin County,	CHARLES P. ALDRICH of Greenfield,	1913
Hampshire,	HOWARD A. PARSONS of Amherst (P. O. North Amherst),	1913
Hampshire, Franklin and Hampden,	RUFUS M. SMITH of Hadley,	1915
Highland,	JOHN T. BRYAN of Middlefield (P. O. Chester, R. F. D.),	1914
Hillside,	HARRY A. FORD of Windsor,	1914
Hingham (Agricultural and Horticultural),	U. S. BATES of Hingham,	1915
Hoosac Valley,	ABNER TOWNE of Williamstown,	1915
Housatonic,	R. H. RACE of North Egremont,	1915
Lenox Horticultural,	ALFRED H. WINGETT of Lenox,	1914
Marshfield (Agricultural and Hort'l),	WALTER H. FAUNCE of Kingston,	1915
Martha's Vineyard,	JAMES F. ADAMS of West Tisbury,	1913
Massachusetts Horticultural,	WILFRID WHEELER of Concord,	1915
Massachusetts Society for Promoting Agriculture,	N. I. BOWDITCH of Framingham,	1915
Middlesex North,	GEO. W. TRULL of Tewksbury (P. O. Lowell, R. F. D.),	1914
Middlesex South,	JOHN J. ERWIN of Wayland,	1914
Nantucket,	HERBERT G. WORTH of Nantucket,	1915
Oxford,	WALTER A. LOVETT of Oxford,	1913
Plymouth County,	AUGUSTUS PRATT of Middleborough (P. O. North Middleborough),	1914
Spencer (Farmers' and Mechs.' Ass'n),	WALTER C. BEMIS of Spencer,	1913
Union (Agricultural and Hort'l),	SYLVESTER H. PEEBLES of Blandford,	1913
Weymouth (Agricultural and Ind'l),	THERON L. TIRRELL of Weymouth (P. O. South Weymouth),	1915
Worcester,	B. W. POTTER of Worcester,	1914
Worcester East,	GEO. F. MORSE of Lancaster,	1915
Worcester North (Agricultural and Driving Association),	L. E. FLETCHER of Fitchburg,	1915
Worcester Northwest (Agricultural and Mechanical),	ALBERT ELLSWORTH of Athol,	1913
Worcester South,	WILLIAM E. PATRICK of Warren,	1913
Worcester County West,	JOHN L. SMITH of Barre,	1914

ORGANIZATION OF THE BOARD.

OFFICERS.

President, ... His Excellency EUGENE N. FOSS, *ex officio*.
1st Vice-President, . . JOHN BURSLEY of West Barnstable.
2d Vice-President, . . WILFRID WHEELER of Concord.
Secretary, ... J. LEWIS ELLSWORTH of Worcester.
Office, Room 136, State House, Boston.

COMMITTEES.

Executive Committee.

Messrs. Wilfrid Wheeler of Concord.
O. E. Bradway of Monson.
Geo F. Morse of Lancaster.
William E. Patrick of Warren.
Charles M. Gardner of Westfield.
Frederick A. Russell of Methuen.
John L. Smith of Barre.
John Bursley of West Barnstable.

Committee on Agricultural Societies.

Messrs. O. E. Bradway of Monson.
Albert Ellsworth of Athol.
T. L. Tirrell of South Weymouth.
Jacob A. Williams of Northbridge.
Ernest W. Payne of Heath.

Committee on Domestic Animals, Poultry and Dairy Products.

Messrs. William E. Patrick of Warren.
Herbert G. Worth of Nantucket.
Abner Towne of Williamstown.
Rufus M. Smith of Hadley.
Sylvester H Peebles of Blandford.

Committee on the Massachusetts Agricultural College and the Massachusetts Agricultural Experiment Station.

Messrs. John Bursley of West Barnstable.
Frank P. Newkirk of Easthampton
Wm. E. Patrick of Warren.
John J. Erwin of Wayland.
R. Henry Race of North Egremont.

Committee on Orcharding and Fruit Growing.

Messrs Wilfrid Wheeler of Concord.
Frederick A Russell of Methuen.
Alfred H. Wingett of Lenox.
Ernest W. Payne of Heath.
Walter C. Bemis of Spencer.

Committee on Grasses and Forage Crops.

Messrs. John L. Smith of Barre.
Harry A. Ford of Windsor.
U. S Bates of Hingham.
N. I. Bowditch of Framingham.
Wilfrid Wheeler of Concord.

Committee on Markets and Transportation.

Messrs. Charles M. Gardner of Westfield.
George W. Thull of Tewksbury.
Burton W. Potter of Worcester.
Howard A Parsons of Amherst.
Walter H. Faunce of Kingston.

Committee on Farm Tools and Machinery.

Messrs. Walter A. Lovett of Oxford.
Jacob A. Williams of Northbridge.
Frank P. Newkirk of Easthampton.
James F. Adams of West Tisbury.
A. Willis Bartlett of Salisbury.

Committee on Institutes and Public Meetings.

Messrs. George F. Morse of Lancaster.
Henry M. Howard of West Newton.
James F. Adams of West Tisbury.
Kenyon L. Butterfield of Amherst.
George W. Trull of Tewksbury.

Committee on Irrigation and Drainage.

Messrs. Frederick A. Russell of Methuen.
Henry M. Howard of West Newton.
Charles P. Aldrich of Greenfield.
John T. Bryan of Middlefield.
John J. Erwin of Wayland.

The secretary is a member, *ex officio*, of each of the above committees.

DAIRY BUREAU.

Messrs. Howard A. Parsons of Amherst, 1912; George W. Trull of Tewksbury, 1913; Charles M. Gardner of Westfield, 1914.

Executive Officer, ... J. L. Ellsworth.
General Agent, ... P. M. Harwood of Barre.

Office, Room 136, State House.

STATE NURSERY INSPECTOR.

Henry T. Fernald, Ph.D., of Amherst.

STATE ORNITHOLOGIST.

Edward Howe Forbush of Wareham.

STATE INSPECTOR OF APIARIES.

Burton N. Gates, Ph.D., of Amherst.

SPECIALISTS.

Chemist,	Dr. J. B. Lindsey,	Amherst.
Entomologist,	Prof. C. H. Fernald,	Amherst.
Botanist,	Dr. Geo. E. Stone,	Amherst.
Pomologist,	Prof. F. C. Sears,	Amherst.
Veterinarian,	Prof. James B Paige,	Amherst.
Engineer,	Wm. Wheeler,	Concord.

MASSACHUSETTS AGRICULTURAL COLLEGE.

Location, Amherst, Hampshire County.

Board of Trustees.	Term expires
Davis R. Dewey of Cambridge,	1912
M. Fayette Dickinson of Boston,	1912
William H. Bowker of Boston,	1913
George H. Ellis of Newton,	1913
Chas. E. Ward of Buckland,	1914
Elmer D Howe of Marlborough,	1914
Nathaniel I. Bowditch of Framingham,	1915
William Wheeler of Concord,	1915
Arthur G. Pollard of Lowell,	1916
Charles A. Gleason of Springfield,	1916
Frank Gerrett of Greenfield,	1917
Harold L. Frost of Arlington,	1917
Frank A. Hosmer of Amherst,	1918
Charles H. Preston of Danvers,	1918

Members ex Officio.

His Excellency Governor Eugene N. Foss,
President of the Corporation.

Kenyon L. Butterfield, LL.D.,	*President of the College.*
David Snedden,	*Commissioner of Education.*
J. Lewis Ellsworth,	*Secretary State Board of Agriculture.*

Officers elected by the Board of Trustees.

Charles A. Gleason of Springfield,	*Vice-President of the Corporation.*
J. Lewis Ellsworth of Worcester,	*Secretary.*
Fred C. Kenney of Amherst,	*Treasurer.*
Charles A. Gleason of Springfield,	*Auditor.*
Kenyon L. Butterfield, LL.D., of Amherst,	*President of the College.*

Examining Committee of the Board of Agriculture.

Messrs. Bursley, Newkirk, Patrick, Erwin and Race.

Massachusetts Agricultural Experiment Station.

William P. Brooks, Ph.D.,	*Director.*
Joseph B. Lindsey, Ph.D.,	*Vice-Director.*
Frank A. Waugh, M.Sc.,	*Horticulturist.*
George E. Stone, Ph.D.,	*Botanist and Vegetable Pathologist.*
Henry T Fernald, Ph D,	*Entomologist.*
James B. Paige, B.Sc., D V.S.,	*Veterinarian.*
John E. Ostrander, A.M., C.E.,	*Meteorologist.*

AGRICULTURAL SOCIETIES INCORPORATED BY SPECIAL ACT OF THE LEGISLATURE, AND REPRESENTED ON THE BOARD OF AGRICULTURE.

NAME.	PRESIDENT.	SECRETARY.	TREASURER.
Amesbury and Salisbury,[1]	A. Willis Bartlett, Salisbury.	M. H. Sands, Amesbury.	John J. Mason, Amesbury.
Barnstable County,	T. C. Thacher, Yarmouthport.	M. N. Harris, Barnstable.	Henry C. Davis, Cummaquid.
Blackstone Valley,	W. A. L. Bazeley, Uxbridge.	Dr. M. R. Sharpe, Uxbridge.	Chas. A. Barton, Uxbridge.
Deerfield Valley,	William B. Avery, Charlemont.	S. W. Hawkes, Charlemont.	C. T. Haskins, Charlemont.
Eastern Hampden,	O. E. Bradway, Monson.	L. E. Chandler, Palmer.	Harry C. Ellithorpe, Palmer.
Essex,	J. M. Danforth, Lynnfield Center.	Fred A. Smith, Ipswich.	Wm. S. Nichols, Salem.
Franklin County,	A. C. Burnham, Montague City.	J. H. Murphy, Greenfield.	Frank H. Snow, Greenfield.
Hampshire,	Francis E. Farrar, Amherst.	Robert S. Belknap, Amherst.	Robert S. Belknap, Amherst.
Hampshire, Franklin and Hampden,	Clarence E. Hodgkins, Northampton.	Chas. A. Montgomery, Northampton.	Alvertus J. Morse, Northampton.
Highland,	John W. Crane, Springfield.	John T. Bryan, R. F. D., Chester.	Wesley A. Olds, Middlefield.
Hillside,	Milton P. Howes, Cummington.	Clement F. Burr, Ringville.	Robert L. Streeter, Cummington.
Hingham,[1]	Alfred L. Lincoln, Hingham.	William L. Howard, Hingham.	Harry F. Zahn, Hingham.
Hoosac Valley,	Dr. F. D. Stafford, North Adams.	George F. Miller, North Adams.	C. J. Arnold, North Adams.
Housatonic,	William I. Walker, Great Barrington.	Joseph H. Maloney, Great Barrington.	George L. Taylor, Great Barrington.
Lenox Horticultural,	George Foulsham, Stockbridge.	George H. Instone, Lenox.	Allan J. Jenkins, Stockbridge.
Marshfield,[1]	Thomas W. Lawson, Boston.	Israel H. Hatch, North Marshfield.	M. Herman Kent, Marshfield.
Martha's Vineyard,	B. T. Hillman, Edgartown.	F. Allen Look, West Tisbury.	George H. Luce, West Tisbury.
Massachusetts Horticultural,	Charles W. Parker, Boston.	William P. Rich, Boston.	Walter Hunnewill, Boston.
Massachusetts Society for Promoting Agriculture,	Charles W. Parker, Boston.	Francis H. Appleton, Boston.	R. M. Saltonstall, Newton.
Middlesex North,	George W. Trull, R. F. D. No. 1, Lowell.	Andrew Liddell, Lowell.	John A. Weinbeck, Lowell.
Middlesex South,	John P. Bowditch, Framingham.	Peter N. Everett, South Framingham.	George E. Fay, Framingham.
Nantucket,	Herbert G. Worth, Nantucket.	Josiah F. Murphy, Nantucket.	Benjamin F. Worth, Nantucket.

[1] And horticultural.

AGRICULTURAL SOCIETIES, ETC. — *Concluded.*

NAME.	PRESIDENT.	SECRETARY.	TREASURER.
Oxford,	Walter E. Schuster, East Douglas.	James E. Darling, Oxford.	George E. Chaffee, Oxford.
Plymouth County,	Augustus Pratt, North Middleborough.	Howard B. Wilbur, Brockton.	Howard B. Wilbur, Brockton.
Spencer Farmers' and Mechanics' Association,	Arthur Monroe, Spencer.	Geo. H. Ramer, Spencer.	Geo. H. Ramer, Spencer.
Union,[1]	Henry K. Herrick, Blandford.	Enos W. Boise, Blandford.	George O. Millard, Blandford.
Weymouth (Agricultural and Industrial),	Ralph P. Burrell, South Weymouth.	A. Francis Barnes, South Weymouth.	D. Frank Daley, South Weymouth.
Worcester,	Walter D. Ross, Worcester.	Elisha S. Knowles, Worcester.	Leander F. Herrick, Worcester.
Worcester East,	John E. Thayer, Lancaster.	Warren Goodale, Clinton.	John W. Forrester, Clinton.
Worcester North (Agricultural and Driving Association),	Lucius L. Richardson, Leominster.	J. C. McMullen, Fitchburg.	Benjamin A. Cook, Fitchburg.
Worcester Northwest (Agricultural and Mechanical),	Fred H. Sprague, Orange.	Albert Ellsworth, Athol.	Ernest L. Worrick, Athol.
Worcester South,	Herman S. Cheney, Southbridge.	C. V. Corey, Sturbridge.	C. V. Corey, Sturbridge.
Worcester County West,	William A. Gaston, Boston.	Daniel H. Rice, Barre.	John S. Rice, Barre.

[1] And horticultural.

Horticultural Societies.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Haverhill,	Haverhill,	Walter Goodrich, Haverhill.	Mrs. William M. Webster, Haverhill.
Hampden County,	Springfield,	Joel H. Hendrick, 632 State St., Springfield.	William F. Gale, 24 Crystal Ave., Springfield.
Houghton,	Lynn,	Frank L. Whipple, Lynn.	Mrs. Nettie L. Day, 20 Webster St., Lynn.
Massachusetts,	The State,	Stephen M. Weld, Boston.	Wm. P. Rich, Horticultural Hall, Boston.
North Shore,	Manchester,	Wm. Till, Magnolia.	James Salter, Manchester.
Springfield Amateur,	Springfield,	A. J. Griffin, Greene St., Springfield.	J. Alden Davis, 36 Groveland St., Springfield.
Worcester County,	Worcester,	Edward W. Breed, Clinton.	Leonard C. Midgley, Westborough.

Farmers' and Mechanics' Associations.

Bolton,	Bolton,	Gilbert H. Wheeler, Bolton.	William M. Brigham, Bolton.
Needham,	Needham,	George S. Coe, 186 Pond St., Natick.	William A. Parks, Needham Heights.
Oakham,	Oakham,	Wayland Angier, Oakham.	M. Idella Angier, Oakham.
Princeton,	Princeton,	J. C. F. Mirick, Princeton.	J. E. Merriam, Princeton.
Westminster,	Westminster,	Chas. F. Knowles, R. F. D. No. 1, Westminster.	George W. Barnes, Westminster.

Farmers' and Mechanics' Clubs.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Ashburnham,	Ashburnham,	E. J. Forristall, South Ashburnham.	W. E. Jefts, Ashburnham.
Belchertown,	Belchertown,	Harry H. Ward, Belchertown.	Almon L. Pratt, Belchertown.
Groton,	Groton,	Wm. A. Lawrence, Groton.	L. H. Sheedy, Groton.
Holden,	Holden,	N. W. Sanborn, M.D., Holden.	George M. Perry, Holden.
Pepperell,	Pepperell,	H. W. Hutchinson, Pepperell.	Charles F. Spaulding, Pepperell.
Shirley,	Shirley,	H. S. Hazen, Shirley Center.	M. W. Longley, Shirley Center.
Shrewsbury,	Shrewsbury,	E. A. Bartlett, Shrewsbury.	Fred J. Stone, Shrewsbury.

Farmers' Clubs.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Boxborough,	Boxborough,	R. Y. Nelson, Boxborough.	G. W. Burroughs, Boxborough.
Buckland,	Buckland,	Charles E. Ward, Buckland.	Miss Lura E. Hite, Shelburne Falls.
East Charlemont,	East Charlemont,	W. W. Smith, East Charlemont.	Horace Wells French, East Charlemont.
Easthampton,	Easthampton,	Geo. Vaugh, Park Hill, Easthampton.	Joel Searle, Easthampton.
Franklin,	Franklin,	George F. Ribrac, Franklin.	L. W. Daniels, Franklin.
Halifax,	Halifax,	Jas. T. Thomas, Halifax.	Mrs. George W. Hayward, Halifax.
Medway,	Medway,	J. G. Sanderson, West Medway.	Miss Beth Wilson, Medway.
New Braintree,	New Braintree,	James E. Barr, New Braintree.	Mrs. Mary Barr, New Braintree.
Rowley,	Rowley,	J. D. Dodge, Rowley.	T. P. Hale, Rowley.
South Bristol,	New Bedford,	Herbert Wing, South Dartmouth.	Allen Russell, Acushnet.
Tatnuck,	Worcester,	C. T. Foster, Hadwen Rd., Worcester.	H. Ward Moore, 28 Amherst St., Worcester.
Upton,	Upton,	Orlando F. Taft, Upton.	Edward B. Newton, Upton.
West Brookfield,	West Brookfield,	A. H. Warfield, West Brookfield.	Sumner H. Reed, West Brookfield.
Wilbraham,	Wilbraham,	B. F. Green, North Wilbraham.	H. M. Bliss, R. F. D. No. 2, Ludlow.

POULTRY ASSOCIATIONS.

Athol Poultry and Pet Stock Association,	Athol,	- - -	J. E. Burt, Athol.
Brockton Poultry Association,	Brockton,	M. E. Holmes, Campello.	C. A. Brown, Brockton.
Dalton Poultry, Pigeon and Pet Stock Association,	Dalton,	G. W. Crow, Dalton.	W. H. Griswold, Dalton.
Essex County Poultry Association,	Essex County,	J. D. Barnes, Wenham.	Arthur Elliot, Peabody.
Holyoke Poultry and Pet Stock Association,	Holyoke,	Albert C. Chapin, Holyoke.	Percy M. Alden, Willimansett.
Lawrence Poultry and Pet Stock Association,	Lawrence,	B. D. Todd, Lawrence.	Asa L. Harris, Lawrence.
Milford Poultry Association,	Milford,	George P. Sheldon, Hopedale.	W. H. Pyne, Milford.
New England Poultry Association,	Greenfield,	J. E. Weatherwax, Oak St., Greenfield.	S. H. Stone, 4 Walnut St., Greenfield.
North Abington Poultry Association,	North Abington,	Chas. W. Pratt, North Abington.	Jas. H. Dwyer, North Abington.
Northern Berkshire Poultry Association,	North Adams,	Wm. G. Carter, North St., North Adams.	C. A. Larabee, North Adams.
Plymouth Poultry Association,	Plymouth,	T. Allen Bagnell, Plymouth.	F. C. Chandler, Kingston.
Springfield Poultry Club,	Springfield,	Geo. W. Pike, Springfield.	- - -
Springfield Poultry and Pet Stock Association,	Springfield,	E. C. Powell, Longmeadow.	E. S. Evans, Springfield.
West Brookfield Poultry Association,	West Brookfield,	R. H. Buffington, West Brookfield.	E. L. Richardson, West Brookfield.
Worcester Poultry Association,	Worcester,	Walter D. Ross, 90 Front St., Worcester.	W. H. Fitton, 42 Richmond Ave., Worcester.

Miscellaneous.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Bay State Agricultural Society,	The State,	C. Minot Weld, Boston.	N. I. Bowditch, Framingham.
Boston Market Gardeners' Association,	Boston,	M. Ernest Moore, Arlington.	James P. Esty, Newton Center.
Brockton Agricultural Society,	Brockton,	Charles Howard, Brockton.	Perley G. Flint, Brockton.
Cape Cod Cranberry Growers' Association,	Cape Cod District,	George E. Taylor, Jr., Shelburne.	O. C. Burt, Easthampton.
Connecticut Valley Breeders' Association,	Western New England,	George R. Briggs, Plymouth.	L. C. Hall, Wareham.
Franklin Harvest Club,	Connecticut Valley,	Charles E. Ward, Buckland.	C. B. Lyman, Southampton.
Hampden Harvest Club,	Connecticut Valley,	Changes each meeting.	Edwin C. Powell, R. F. D. No. 2, Ludlow.
Haverhill Agricultural Society,	Haverhill,	Edward H. George, Groveland.	Leslie K. Morse, Haverhill.
Massachusetts Cattle Owners' Association,	The State,	B. W. Potter, Worcester.	J. L. Harrington, Lunenburg.
Massachusetts Creamery Association,	The State,	W. H. Wright, Easthampton.	Prof. W. P. B. Lockwood, Amherst.
Massachusetts Dairymen's Association,	The State,	John P. Bowditch, Framingham.	Prof. W. P. B. Lockwood, Amherst.
Massachusetts Forestry Association,	The State,	N. T. Kidder, Ames Building, Boston.	Harris A. Reynolds, 4 Joy St., Boston.
Massachusetts Fruit Growers' Association,	The State,	S. T. Maynard, Northborough.	F. Howard Brown, Hosmer St., Marlborough.
Massachusetts Nurserymen's Association,	The State,	Windsor H. Wyman, North Abington.	A. E. Robinson, Bedford.
Massachusetts Society of Beekeepers,	The State,	E. Clinton Britton, Canton.	Thomas J. Hawkins, 4 Emery St., Everett.
Massachusetts State Poultry Association,	The State,	Henry D. Smith, Rockland.	W. H. McClary, South Hanover.
Stockbridge Club,	Amherst,	R. C. Barrows, M. A. C., Amherst.	R. A. Warner, M. A. C., Amherst.
Ware Agricultural Society,	Ware,	F. F. Gilmore, Ware.	E. P. Lovett, Ware.
Worcester County Harvest Club,	Worcester County,	A. C. Stoddard, North Brookfield.	Mrs. D. A. Howe, 8 Burncoat St., Worcester.
Worcester County Beekeepers' Association,	Worcester County,	John L. Byard, Marlborough.	C. H. Goodell, Worcester.

MASSACHUSETTS PATRONS OF HUSBANDRY.

Officers of the State Grange, 1912.

Master,	Charles M. Gardner of Westfield.
Overseer,	E. E. Chapman of Ludlow.
Lecturer,	E. F. Richardson of Millis.
Steward,	L. R. Smith of Hadley.
Assistant Steward,	E. H. Gilbert of Stoughton (P. O. address, North Easton).
Chaplain,	Rev. A. H. Wheelock, Marlborough.
Treasurer,	Hon. F. A. Harrington of Worcester.
Secretary,	Wm. N. Howard of South Easton (P. O. address, North Easton).
Gate Keeper,	F. L. Warfield of Buckland.
Ceres,	Mrs. Mary Olds Lakin of Brookfield.
Pomona,	Mrs. Ella D. Rice of Leominster.
Flora,	Mrs. Laura M. Sargent of Amesbury.
Lady Assistant Steward,	Mrs. Ida Littlefield of Norwood.

Executive Committee.

C. A. Dennen,	Pepperell.
W. C. Jewett,	Worcester.
George S. Ladd,	Sturbridge.

General Deputies.

N. B. Douglas,	Sherborn.
Elmer D. Howe,	Marlborough.
Warren C. Jewett,	Worcester.
George S. Ladd,	Sturbridge.
C. D. Richardson,	West Brookfield.

Pomona Deputies.

F. N. Boutelle,	West Townsend.
Wilbert T. Moore,	Huntington.
Joseph W. Baldwin,	North Easton.

Subordinate Deputies.

Geo. W. Sherman,	Brimfield.
L. H. Cudworth,	Oxford.
W. H. Sawyer,	Winchendon.
W. A. Harlow,	Cummington.
H. N. Jenks,	R. F. D., Adams.
Elbridge Noyes,	Newbury.
T. E. Flarity,	Townsend.
Moses U. Gaskill,	Mendon.
E. B. Hale,	Bernardston.
Hermon W. King,	East Longmeadow.
John Bursley,	West Barnstable.
C. R. Damon,	Williamsburg.
W. T. Herrick,	Westborough.
H. W. Carter,	Millbury.
Chester B. Williams,	Cochituate.

SUBORDINATE DEPUTIES — *Con.*

Walter E. Morris, ... Medfield.
S. T. Brightman, ... Westport.
Horace E. Wallis, ... Waltham.
Charles H. Preston, ... Danvers.
Dr. M. H. Williams, ... Sunderland.
Fred E. Alden, ... Fitchburg.
Norman L. Peavey, ... Dracut.
Arthur W. Gorham, ... North Hanson.
Peter I. Adams, ... Stockbridge.

SPECIAL DEPUTIES.

Wm. N. Howard, ... North Easton.
J. P. Ranger, ... North Brookfield.
C. H. Shaylor, ... Lee.
Geo. L. Averill, ... Andover.

STANDING COMMITTEE ON BIRDS.

Charles H. Rice, ... Leominster.
C. H. Higgins, ... Uxbridge.
Mrs. E. O. Marshall, ... New Salem.

RECESS COMMITTEE ON TAXATION.

Charles H. Preston, ... Danvers.
John N. Hillman, ... Hardwick.
Lewis B. Paine, ... Dover.

TRUSTEES OF EDUCATIONAL FUND.

Evan F. Richardson, *Chairman*, ... Millis.
Mrs. Rose F. Ladd, *Secretary*, ... Sturbridge.
James C. Poor, *Treasurer*, ... North Andover.
Charles M. Gardner, ... Westfield.
John H. Noble, ... Pittsfield.

Massachusetts Patrons of Husbandry — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Pomona Granges.			
Middlesex and Norfolk, No. 1,	Joseph Mason, Newton Upper Falls.	Abel F. Stevens, Wellesley.	Nellie S. Stevens, Wellesley.
Essex County, No. 2,	Albert P. Wadleigh, Merrimac.	Edward A. H. Grover, Danvers.	Miss Matilda B. Lund, R. F. D. No. 1, Ward Hill.
Middlesex-Worcester, No. 3,	Millard S. Sawyer, Groton.	Mrs. Blanche Brown, Groton.	Mrs. Minnie L. F. Knight, Townsend Harbor.
Franklin and Worcester, No. 4,	E. S. Putnam, Wendell Depot.	Mrs. Nellie H. Drake, Orange.	Mrs. Ellen M. Conant, North Orange.
Worcester West, No. 5,	Calvin Drury, Princeton.	Mrs. S. Alice Hillman, Gilbertville.	Mrs. R. S. Titterten, Templeton.
Berkshire County, No. 6,	T. L. Curran, R. F. D., Housatonic.	J. J. Glynn, Dalton.	J. C. Jenks, R. F. D., Adams.
Worcester Central, No. 7,	Edward P. Davidson, West Millbury.	Mrs. C. H. Freeman, 154 Lincoln St., Worcester.	A. E. Grout, Millbury.
Hampshire County, No. 8,	M. H. Williams, Sunderland.	Mrs. D. E. Clary, Williamsburg.	Mrs. C. R. Damon, Williamsburg.
Worcester Southwest, No. 9,	William H. Eccleston, Southbridge.	Mrs. Nettie M. Webster, Sturbridge.	Mrs. Helen E. Clemence, Southbridge.
Worcester and Norfolk, No. 10,	Frank H. Wood, Mendon.	Moses U. Gaskill, Mendon.	Mrs. Annie E. Gaskill, South Milford.
Borough, No. 11,	Alfred Ordway, Hudson.	Mrs. S. M. Thompson, R. F. D. No. 2, Westborough.	Mrs. Maria A. Gilmore, R. F. D. No. 2, Box 13, Westborough.
Springfield, No. 12,	H. L. Moody, East Longmeadow.	Mrs. A. E. Ballard, Hampden.	Mrs. Carrie L. Hayward, Agawam.
Old Colony, No. 13,	J. Herbert Cushing, Middleborough.	Wm. N. Howard, North Easton.	Alida N. Stevens, 75 Tremont St., South Braintree.
Worcester East, No. 14,	J. Henry Johnson, Leominster.	Mrs. Jennie M. Vinton, Leominster.	Mrs. Ida A. Cunningham, Lancaster.
Quaboag, No. 15,	Edwin L. Havens, New Braintree.	Mrs. Bertie A. Barnes, Brimfield.	Mrs. Carrie E. Webb, West Brookfield.
Middlesex North, No. 16,	James A. Ruth, North Billerica.	Mrs. Helen L. Reinhard, Wilmington.	Mrs. Lulu M. Hutchins, Billerica.
Deerfield Valley, No. 17,	D. P. Bardwell, Bardwells Ferry.	Mrs. Florence Butler, East Charlemont.	Miss Alice Bardwell, Shattuckville.
Western Hampden, No. 18,	Amasa Holcomb, Southwick.	Mrs. Chas. M. Gardner, Westfield.	Annette Sackett, Westfield.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Connecticut Valley, No. 19,	C. M. Hemenway, North Leverett.	Mrs. Mertie U. Clapp, Northfield.	Mrs. Emma L. Barton, Riverside.
Hillside, No. 20,	H. G. Ely, Cummington.	C. A. Williams, Plainfield.	Mrs. G. L. Miner, East Windsor.
Swift River Valley, No. 21,	Edgar D. Winslow, Ware.	Geneva Sieg Ballard, Millington.	Mrs. Sewall King, Cooleyville.
Mayflower, No. 22,	Le Roy M. Peterson, Millbrook.	Miss Nannie B. Holmes, South Hanson.	Winthrop Fillebrown, Bryantville.
Middlesex Central, No. 23,	Sylvester P. Robertson, Townsend.	Frank Tyler Marston, 20 Fairmount St., Melrose.	Mrs. E. M. Hutchinson, R. F. D. No. 2, Lexington.
Cape Cod, No. 24,	Robert S. Handy, Cataumet.	Frank E. Howes, Dennis.	Henry C. Davis, Cummaquid.
Berkshire South, No. 25,	Edwin H. Cande, Sheffield.	L. R. Miller, Great Barrington.	Mrs. Fred Lockwood, Mill River.
Chebacco, No. 26,	Geo. C. Donaldson, South Hamilton.	David S. Stranger, 26 Berry St., Danvers.	Frances M. Smith, R. F. D., Ipswich.
Norfolk, No. 27,	Edward H. Williams, Foxborough.	Annie Stowell, Walpole.	Mrs. Carrie Snyder, Walpole.
Subordinate Granges.			
"Guiding Star" of Greenfield,	Miss Martha A. Sprague, Greenfield.	Mrs. Henrietta Snyder, Greenfield.	Mrs. A. M. Handforth, Greenfield.
Deerfield, No. 2,	Lewis J. Smith, Deerfield.	Samuel P. Billings, Deerfield.	P. G. Davis, Deerfield.
Northfield, No. 3,	Robert D. Ware, Northfield.	Rev. Arthur E. Wilson, Northfield.	Martha E. Callendar, Northfield.
Groton, No. 7,	Millard S. Sawyer, R. F. D., Groton.	Mrs. Elizabeth Sawyer, R. F. D., Groton.	Miss Lois M. Wright, Groton.
Barre, No. 9,	Wm. M. Cochran, Barre.	Mrs. C. A. Wheeler, Barre.	Mrs. Lyman B. Crane, Barre.
Pittsfield, No. 14,	John Buckler, Blythewood Farms, Pittsfield.	Mrs. Edgar Howland, R. F. D. No. 2, Pittsfield.	Ralph H. Elmer, Holmes Road, Pittsfield.
"Hope" of Hadley, No. 15,	Edward P. West, Hadley.	Mrs. Austin Cook, Hadley.	Mrs. Lyman Cook, Hadley.
Amherst, No. 16,	H. A. Parsons, North Amherst.	Mrs. Chas. Strong, Amherst.	Mary Helen Scott, Amherst.
Cheshire, No. 17,	Geo. M. Purdy, Cheshire.	Mrs. F. W. Cox, Cheshire.	Mrs. Maude L. Purdy, Cheshire.
Hinsdale, No. 19,	Jesse A. Miner, Hinsdale.	Miss Harriett Tracy, Hinsdale.	Mrs. J. A. Miner, Hinsdale.
Westfield, No. 20,	Wayne D. Wood, Westfield.	Mrs. Frank A. Phelps, Westfield.	Annettee Sackett, Westfield.
Lanesborough, No. 21,	Charles E. Chadwick, Lanesborough.	Mrs. Harriett E. Rice, Lanesborough.	Mrs. Ella L. Foster, Lanesborough.
Worcester, No. 22,	Harold J. Greenwood, 193 May St., Worcester.	Mrs. Isabelle C. Vaughan, 18 Dover St., Worcester.	Mrs. Nancy E. Moore, 92 Summer St., Worcester.

Dalton, No. 23,	John J. Glynn, Dalton.	Mrs. E. R. Morse, Pittsfield.	Clair C. Barton, Dalton.
Blandford, No. 24,	C. R. Ripley, Chester.	Mrs. Frank Cook, Blandford.	Ira Aitken, Blandford.
New Lenox, No. 26,	Louis E. Stickles, Lenox.	Madeline B. Clark, New Lenox.	Horatio H. Sears, New Lenox.
Easthampton, No. 27,	D. A. Forbes, West St., Easthampton.	Mrs. Geo. Porter, Pomeroy Court, Easthampton.	Miss Lilian Bristow, Fairfield Ave., Easthampton.
Richmond, No. 32,	Mrs. Ida B. Coleman, R. F. D. No. 1, Richmond.	R. E. Annin, Jr., Richmond.	Miss Ida H. Barnes, Richmond.
Adams, No. 34,	Chas. A. Daniels, 18 Orchard St., Adams.	Mrs. Fannie Sherman, Spring St., Adams.	Mrs. Lillian Daniels, 18 Orchard St., Adams.
Russell, No. 36,	Glenn C. Sevey, Russell.	Mrs. Jas. Walkingham, Russell.	Mrs. Pearl Baldwin, Russell.
"Thrifty" of Leverett, No. 37,	Geo. W. Morrison, Leverett.	Mrs. M. H. Briggs, Leverett.	F. N. Bourne, Moore's Corner.
Granville, No. 40,	Harry S. Hartley, Granville.	Mrs. Clara M. Hartley, Granville.	Mrs. L. G. Noble, Granville.
Montgomery, No. 45,	Myron E. Kelso, Montgomery.	Mrs. E. A. Moore, Montgomery.	Florence B. Moore, Montgomery.
Southwick, No. 46,	Amasa Holcomb, Southwick,	Mrs. C. G. Stone, Southwick.	C. A. Griffin, Southwick.
Becket, No. 47,	Howard R. Molineau, Becket.	Mrs. A. E. Moger, Becket.	Miss Emma Bullard, Becket.
"Highland" of Huntington, No. 48,	Joseph H. Hewitt, Huntington.	Miss Luella E. Maher, Huntington.	Mrs. R. A. Jenkins, Huntington.
"Granite" of South Worthington, No. 49.	Rufus H. Adams, Ringville.	Mrs. Harriet Higgins, Ringville.	Mrs. J. H. Witherell, South Worthington.
"Golden Rule" of Prescott, No. 52,	Frank R. Allen, R. F. D. No. 1, Greenwich Village.	Mrs. Delia H. Petrie, R. F. D. No. 1, Greenwich Village.	Miss Celia E. Currier, North Prescott.
Sterling, No. 53,	Rodney E. Monk, Pratt's Junction.	George R. Kendall, Sterling.	Frank P. Elliott, Sterling.
Springfield, No. 54,	Franklin N. Newell, 31 Elm St., Rm. 231, Springfield.	Mrs. Lulu Merrill (Forest Glen), Longmeadow.	Mrs. Lillian A. Cornell, 307 Main St., Springfield.
Cummington, No. 56,	W. A. Harlan, Swift River.	Mrs. Lida A. Liebenow, Cummington.	W. E. Ford, Cummington.
Auburn, No. 60,	Everett W. Stone, Auburn.	Mrs. Alice E. Kepp, Auburn.	Miss Linnie E. Keep, Auburn.
Egremont, No. 63,	Ray W. Spurr, R. F. D. No. 3, Great Barrington.	Mrs. G. A. Brewster, South Egremont.	Mrs. A. Dunlap, R. F. D. No. 3, Great Barrington.
"Union" of Belchertown, No. 64,	Alvin R. Louis, Belchertown.	Mrs. E. A. Howard, Belchertown.	Miss Rose M. Olds, Belchertown.
Brimfield, No. 65,	Orlo Parker, R. F. D., Brimfield.	Fred N. Lawrence, Brimfield.	Rev. W. L. Jennings, Brimfield.
Charlemont, No. 66,	H. E. Warfield, Charlemont.	Mrs. Sara K. Stacy, Charlemont.	D. J. Davenport, Charlemont.
Hardwick, No. 67,	Ollie A. Tuttle, R. F. D., Gilbertville.	Mrs. J. D. Hillman, Hardwick.	Mrs. N. L. Smith, Hardwick.

Massachusetts Patrons of Husbandry — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Shelburne, No. 68,	C. O. Loomis, Box 94, Greenfield.	Mrs. C. S. Dole, R. F. D., Shelburne.	Mrs. C. O. Loomis, Box 94, Greenfield.
Ashfield, No. 69,	Harold K. Howes, Watson.	Fordyce Thayer, R. F. D., Ashfield.	Mrs. Will Howes, Watson.
Phillipston, No. 70,	D. Webster Baker, R. F. D. No. 3, Athol.	Mrs. Ella R. White, R. F. D. No. 3, Athol.	Mrs. Cora A. Dunton, Phillipston.
Leyden, No. 71,	Mrs. Gratia Campbell, Leyden.	Miss Jessica Ballou, Leyden.	Mrs. Lucy Howes, Leyden.
"Prescott" of Pepperell, No. 73,	Walter L. Shattuck, East Pepperell.	Mrs. Minnie D. Green, Pepperell.	Miss S. Luella Parker, East Pepperell.
Princeton, No. 74,	Raymond J. Gregory, Princeton.	J. Harry Allen, Princeton.	Miss Florence Bryant, Brooks Station.
Colrain, No. 76,	Frank A. Walden, Colrain.	Mrs. Henry A. Dwight, Adamsville.	Miss Alice N. Bardwell, Shattuckville.
Windsor, No. 77,	G. L. Miner, East Windsor.	Mrs. Charles Hathaway, East Windsor.	Mrs. G. L. Miner, East Windsor.
Holden, No. 78,	Albert A. Graham, R. F. D., Holden.	Dr. C. W. Stickney, Holden.	Mrs. Wm. J. Powers, Holden.
Spencer, No. 79,	Thomas K. Faxon, Spencer.	Mrs. Sara Monroe, Spencer.	Miss Bertha M. Smith, Spencer.
Bernardston, No. 81,	E. B. Hale, Bernardston.	Mrs. C. S. Hale, Bernardston.	Miss Mary Slate, Bernardston.
"Manhan" of Southampton, No. 82.	C. S. Hooker, Southampton.	Rev. W. H. Adams, Southampton.	Miss Julia E. Norris, Southampton.
Chesterfield, No. 83,	H. L. Merritt, Chesterfield.	Rev. M. T. Anderson, Chesterfield.	Miss Katherine Quinn, Chesterfield.
Warwick, No. 85,	Sumner H. Baker, Warwick Stage, Orange.	Rev. John Graham, Warwick.	George A. Witherell, Warwick Stage, Orange.
North Orange, No. 86,	W. E. Blackmer, R. F. D. No. 2, Orange.	Miss Mary G. Prentice, Tully.	Galan A. Miller, North Orange.
Buckland, No. 87,	Hezekiah E. Ward, Buckland.	Frank D. Wiley, Buckland.	Mrs. Tella W. Wells, Shelburne Falls.
Lee, No. 88,	Chas. F. Bradley, Lee.	Mrs. W. A. Dikeman, Lee.	Mrs. H. J. Voght, Lee.
Worthington, No. 90,	Edw. J. Clark, Worthington.	Mrs. Ernest Thayer, West Worthington.	Arthur Capen, Worthington.
Charlton, No. 92,	William Casey, Charlton Depot.	W. Ernest Rich, Charlton.	Mrs. Rose E. Bowers, Charlton Depot.
Grafton, No. 93,	S. Lothrop Davenport, North Grafton.	Mrs. Lizzie Harrington, North Grafton.	Eva M. Sibley, Grafton.
Petersham, No. 95,	Benj. W. Towne, Petersham.	Miss Maria E. Williams, Petersham.	Mrs. Ruby J. Stone, Petersham.
Savoy, No. 99,	W. S. Hathaway, Savoy.	Mrs. Bertha Renfrew, Savoy.	Mrs. C. A. Maranville, Savoy.
Shrewsbury, No. 101,	Wesley D. Bates, Box 44, Shrewsbury.	Charles W. Walker, R. F. D., Shrewsbury.	Mrs. M. E. Chamberlin, R. F. D., Shrewsbury.

Stow, No. 103,	Otto H. Geers, R. F. D., West Acton	Mrs. Edythe W. Geers, R. F. D., West Acton.	Philip N. Glazier, Box 263, Maynard.
"Garfield" of North Dana, No. 104,	H. B. Eddy, R. F. D., North Dana.	Mrs. Nellie Brown, North Dana.	Miss Celia Whitaker, R. F. D., North Dana.
Marlborough, No. 105,	Lambert A. Noyes, Curtis St., Marlborough.	Mrs. O. A. Norton, 65 Mechanic St., Marlborough.	Mrs. Elmer D. Howe, Fair View Farm, Marlborough.
West Boylston, No. 106,	Frank H. Baldwin, Box 12, West Boylston.	Mrs. Wm. C. Hall, Oak Terrace Farm, Box 34, West Boylston.	Mrs. Mary A. Cook, Box 193, West Boylston.
Millbury, No. 107,	Dr. A. G. Hurd, Millbury.	Mrs. F. L. Simmons, Millbury.	Lloyd Glover, West Millbury.
Hudson, No. 108,	Dennis Eldridge, R. F. D., Hudson.	Miss Claire MacKay, R. F. D., Stow.	Mrs. Mary E. Lawrence, 55 Lincoln St., Hudson.
Sutton, No. 109,	John E. Gifford, Sutton.	Mrs. O. E. Smith, Sutton.	Mrs. H. L. Ray, Sutton.
Sherborn, No. 110,	Joel H. Stratton, R. F. D., South Framingham.	B. W. Lanphear, Sherborn.	Julia N. Daniels, Sherborn.
Boylston, No. 111,	Fred C. Stark, R. F. D., Boylston.	Mrs. Effie G. Mead, R. F. D., Boylston.	Mrs. Edna Garfield, R. F. D., Boylston.
East Medway of Millis, No. 112,	Woodworth J. Rice, Millis.	Clarence E. Simpson, Millis.	Edward E. Adams, Millis.
Framingham, No. 113,	Mervin R. Parsons, R. F. D. No. 2, South Framingham.	Mrs. C. A. Stearns, Saxonville.	George E. Fay, 35 Winter St., Framingham.
Medfield, No. 114,	Mrs. Clara A. Clark, R. F. D., Medfield.	Turner R. Bailey, Medfield.	Alanson H. Clark, R. F. D., Medfield.
Holliston, No. 115,	Justin F. Vaughan, Metcalf.	Herbert E. Jones, Holliston.	Mrs. Nellie V. Pope, Holliston.
Westborough, No. 116,	B. Howard Fay, Westborough.	W. T. Herrick, Westborough.	Mrs. Julia H. Rogers, Box 5, R. F. D. No. 2, Westborough.
Dover, No. 117,	J. V. Schaffner, R. F. D., Dover.	Mrs. Caroline McClure, R. F. D., Dover.	Miss Elizabeth Heard, Dover.
Southborough, No. 118,	Wm. H. Onthank, R. F. D., Southborough.	Edward F. Collins, Southborough.	Mrs. Fred Wells, Fayville.
Northborough, No. 119,	Chester E. Hildreth, Northborough.	Mrs. Elsie J. Mills, Northborough.	Miss Emma N. Cutler, Northborough.
Lancaster, No. 120,	Clifford Cassidy, Lancaster.	J. Fred Brown, South Lancaster.	Warren Leise, South Lancaster.
Sudbury, No. 121,	Rev. Geo. H. Clarke, Sudbury.	Mrs. Maud M. Clarke, R. F. D., South Sudbury.	Miss Eunice A. Baldwin, R. F. D., South Sudbury.
Templeton, No. 122,	A. C. Fairbanks, Templeton.	Mrs. E. B. Burnheimer, Templeton.	Mrs. R. S. Titterton, Templeton.
Oxford, No. 123,	Ernest O. Howe, R. F. D., Oxford.	Miss A. Maud Townsend, R. F. D., Oxford.	Mrs. Cassie G. Adams, Box 63, Oxford.
Ashland, No. 124,	Miss Alice Stone, Ashland.	Chas. E. Burr, Ashland.	Mrs. Emma C. Luce, Ashland.
Upton, No. 125,	Francis A. Smith, Upton.	Mrs. Emale Newton, Upton.	Mrs. L. Jennie Chapman, West Upton.
Hubbardston, No. 126,	Mrs. Mabel I. Smith, Hubbardston.	Mrs. Mary McWilliams, Hubbardston.	Miss Grace R. Prentiss, Hubbardston.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Amesbury, No. 127,	Edmund M. Bartlett, R. F. D. No. 1, Salisbury.	John P. Titcomb, 111 Friend St., Amesbury.	Charles F. Tibbets, 220 Main St., Amesbury.
North Andover, No. 128,	Fred D. Whittier, North Andover.	Leon H. Bassett, North Andover.	Walter H. Hayes, North Andover.
Lincoln, No. 129,	Wm. C. Pierce, South Lincoln.	Wm. C. Robus, Lincoln.	Miss May Doherty, Lincoln.
Gardner, No. 130,	Philip R. Welch, Elm St., Gardner.	Mrs. Mary A. Stone, 177 Chestnut St., Gardner.	Mrs. Mabel C. Bolster, 66 Glenwood St., Gardner.
Boxborough, No. 131,	Arthur W. Nelson, West Acton.	Mrs. S. D. Salmon, 3d, West Acton.	Stephen D. Salmon, 3d, West Acton.
North Brookfield, No. 132,	Alvin L. Newman, North Brookfield.	Mrs. Luella McCarthy, North Brookfield.	Mrs. Mary A. Howe, North Brookfield.
Berlin, No. 134,	Arthur F. Sawyer, Berlin.	Mrs. Clara Matthews, Hudson.	Mrs. Bertha M. Cole, Berlin.
Norfolk, No. 135,	Mrs. Hattie B. Day, Norfolk.	Edwin H. Holbrook, Norfolk.	Mrs. Emma F. Holbrook, Norfolk.
Ipswich, No. 136,	Harry E. Mudrock, Danvers.	Mrs. Frances M. Smith, Turner Hill.	Mrs. Helen M. Moulton, Essex Rd., Ipswich.
East Blackstone, No. 137,	Ralph M. Estes, R. F. D., Blackstone.	Mrs. Sabra Bennett, R. F. D., Blackstone.	Miss B. M. Fernald, R. F. D., East Blackstone.
Northampton, No. 138,	William Phillips, Northampton.	Mrs. Josiah Parsons, Northampton.	Mrs. Bessie Gloyd, Northampton.
East Sandwich, No. 139,	Ernest D. Cameron, Marston's Mills.	Alex. B. Chase, West Barnstable.	George E. S. Elles, East Sandwich.
West Boxford, No. 140,	Alfred K. Nason, West Boxford.	Mrs. H. F. Chadwick, West Boxford.	Miss Matilda B. Lund, R. F. D. No. 1, Ward Hill.
Montague, No. 141,	Walter Eddy, Montague.	Mrs. Kate Hayden, Montague.	Mrs. Eva G. Farnsworth, Montague.
Bolton, No. 142,	Gilbert H. Wheeler, R. F. D., Bolton.	Miss Eva C. Marple, R. F. D., Stow.	Mrs. Arthur H. Nourse, Bolton.
Mendon, No. 143,	Roy A. Barrows, Mendon.	Mrs. Sarah J. Wood, Mendon.	Burton W. Sanderson, Mendon.
Franklin, No. 144,	Charles E. Adams, 65 Cottage St., Franklin.	M. J. Van Leuwen, Central St., Franklin.	Mrs. Susie E. Adams, 65 Cottage St., Franklin.
Douglas, No. 145,	Edward D. Leonard, Box 3, Manchaug.	Mrs. Minnie E. Park, Douglas.	Miss Alma Quintal, East Douglas.
West Newbury, No. 146,	Fred W. Smith, R. F. D., West Newbury.	Mrs. Ruth A. Ruddock, Groveland.	Mrs. Harriet M. Ware, West Newbury.
West Springfield, No. 147,	Homer B. Miller, R. F. D. No. 1, West Springfield.	Mrs. Cornelia Fisher, R. F. D. No. 1, West Springfield.	Lillian M. Capron, 27 Hanover St., West Springfield.

Harvard, No. 149,	Henry A. Knight, Harvard.	Mrs. Etta M. Ripley, Harvard.	Miss Mildred E. Tooker, Littleton.
Concord, No. 150,	Edwin A. Caldwell, Concord Junction.	Frederick Taylor, Concord Junction.	Clara M. Pettigrew, Concord Junction.
East Longmeadow, No. 152,	Frank C. Burton, East Longmeadow.	Mrs. K. Adella Wood, East Longmeadow.	Mrs. Clara B. Cooley, East Longmeadow.
Wilbraham, No. 153,	Edwin C. Powell, R. F. D. No. 2, Ludlow.	Mrs. Edgar C. Clark, R. F. D. No. 2, Ludlow.	Alfred H. Bosworth, R. F. D. No. 2, Ludlow.
Haverhill, No. 154,	E. E. Dickey, Washington Sq., Haverhill.	Miss Annie M. Adams, 51 Broadway, Haverhill.	Mrs. Grace A. Merrill, 1231 Broadway, Haverhill.
Methuen, No. 155,	Frank A. Gordon, 96 Arnold St., Methuen.	Miss Elsie R. Thom, 34 Hawthorne Ave., Methuen.	Harold S. Pedlu, 174 Broadway, Methuen.
West Bridgewater, No. 156,	Mrs. Anna S. LeLacheur, West Bridgewater.	Henry J. LeLacheur, West Bridgewater.	Rhoda F. Wilbur, West Bridgewater.
Granby, No. 157,	Frank M. Graves, Granby.	Mrs. Howard Cleveland, Granby.	Miss Gladys Rust, Granby.
"Nemasket" of Middleborough, No. 158.	William T. Dunham, R. F. D., North Middleborough.	Mrs. Geo. H. Morse, Middleborough.	Annie D. Deane, Middleborough.
"Green River" of Williamstown, No. 159.	Frederick A. West, Williamstown.	Miss Helen Fowler, Williamstown.	Mrs. Jessie B. Torrey, Williamstown.
South Hadley, No. 160,	Geo. F. Turner, South Hadley Falls.	Myra M. Forbes, South Hadley.	Mrs. Eugene Lyman, South Hadley.
"Laurel" of West Newbury, No. 161.	Stephen H. Brown, West Newbury.	S. Waldo Bailey, West Newbury.	Edgar Bartlett, West Newbury.
Dartmouth, No. 162,	Elmer E. Gifford, South Westport.	Mrs. Frank A. Davoll, Dartmouth.	Mrs. J. Frank Briggs, Dartmouth.
Dudley, No. 163,	Geo. B. Truell, Dudley.	Frank Putnam, Dudley.	Mabel W. Merrill, Dudley.
Ware, No. 164,	F. D. Buffington, R. F. D. No. 1, Ware.	Mrs. A. G. Buffington, R. F. D. No. 1, Ware.	Miss M. R. Howard, R. F. D. No. 1, Ware.
Hampden, No. 165,	James L. Mulroney, Hampden.	Mrs. A. F. Ballard, Hampden.	Miss Alice W. May, Hampden.
Wellesley, No. 166,	John F. Mills, Needham.	G. Howard Frost, West Newton.	William A. Parks, Needham Heights.
Rowe, No. 167,	Rev. Margaret B. Barnard, Rowe.	Miss Jennie A. Kirk, Rowe.	Mrs. Anna L. Henry, Rowe.
Somerset, No. 168,	Chester B. Hathaway, R. F. D., Somerset.	Mrs. Mary E. Rice, Pottersville.	Miss Lois A. Davis, R. F. D., Somerset.
Lunenburg, No. 169,	William A. Warren, Lunenburg.	Clayton E. Stone, Lunenburg.	Thomas Aker, Lunenburg.
New Braintree, No. 170,	Mrs. Julia A. Ross, North Brookfield.	Miss Clara K. Kittredge, North Brookfield.	Mrs. Kittie C. Pollard, North Brookfield.
Merrimac, No. 171,	Albert P. Wadleigh, Church St., Merrimac.	Mrs. Carrie Bartlett, Merrimac.	Mrs. Cora L. Wadleigh, Church St., Box 149, Merrimac.
Ashby, No. 172,	William S. Green, Ashby.	Miss Vera Robbins, Ashby.	Mrs. Lucy M. Bingham, Ashby.
Hopkinton, No. 173,	Frank C. Leighton, Hopkinton.	Mrs. Minnie Holcombe, Hopkinton.	Miss Minnie Kilburn, Hopkinton.

Massachusetts Patrons of Husbandry — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Brookfield, No. 174,	Walter B. Mellen, Brookfield.	Miss Teresa Mulvey, R. F. D., Brookfield.	Mrs. Jennie H. Bemis, Brookfield.
Athol, No. 175,	George Marshall, 312 Drury Ave., Athol.	Mrs. Mary Cross, 108 Highland Ave., Athol.	Mrs. Minnie Spaulding, Sanders St., Athol.
"Millers River" of Orange, No. 176,	Wm. A. Johnson, South Rd., Orange.	Mrs. Mabel Marsh, 19 Whitney St., Orange.	Henry J. Coleman, 24 Summit St., Orange.
Sturbridge, No. 177,	Fred E. Webster, Sturbridge.	Harry C. Shepard, Globe Village, Sturbridge.	Mrs. Phila P. Holmes, R. F. D. No. 2, Southbridge.
Ludlow, No. 179,	Wm. Ashwell, Ludlow.	Archer Bennett, Ludlow.	Mrs. Chas. Chapman, Ludlow.
West Brookfield, No. 180,	John H. Webb, West Brookfield.	Mrs. Myra E. Sibley, West Brookfield.	Mrs. Nellie M. Thacher, West Brookfield.
Westport, No. 181,	Arthur T. Potter, R. F. D. No. 1, Westport.	Mrs. E. S. Brightman, Westport.	Chas. A. Brightman, R. F. D. No. 1, Westport.
Southbridge, No. 182,	Elliott M. Clemence, R. F. D. No. 3, Southbridge.	Mrs. Sarah Torrey, R. F. D. No. 1, Southbridge.	Mrs. Ruth D. Nichols, 179 Oliver St., Southbridge.
Andover, No. 183,	Geo. M. Carter, R. F. D. No. 1, Andover.	Miss C. M. Hewes, Porter Rd., Andover.	Edw. W. Burtt, R. F. D. No. 1, Andover.
Topsfield, No. 184,	Geo. Tilton, R. F. D., Topsfield.	Mrs. Grace Smerage, Topsfield.	Miss G. Bradstreet, Topsfield.
Fitchburg, No. 186,	Henry F. Rodimon, R. F. D. No. 1, Fitchburg.	Mrs. Alice H. Arnold, 191 Elm St., Fitchburg.	Mrs. Nettie A. Woodman, 487 Water St., Fitchburg.
Littleton, No. 188,	Richard T. Barrow, R. F. D., Concord Junction.	Mrs. Fannie L. Barrow, R. F. D., Concord Junction.	Miss A. W. Smith, Littleton Common.
Warren, No. 189,	Charles E. Bliss, Warren.	Mrs. Laura B. Covell, Warren.	Mrs. Flora Belle Patrick, Warren.
Bellingham, No. 190,	Walter L. Bennett, South Milford.	Emily L. Bennett, South Milford.	Ada H. Greenwood, Box 95, Milford.
Winchendon, No. 192,	Geo. W. Gregory, Winchendon.	L. Gertrude Noyes, Winchendon.	Charles W. Brooks, Winchendon.
Foxborough, No. 193,	Walter S. Mann, R. F. D., Foxborough.	Edward H. Williams, Foxborough.	Nellie F. Capen, Box 2, Foxborough.
Townsend, No. 194,	Galan A. Proctor, R. F. D., Townsend Harbor.	Wilbur H. Scales, Townsend.	Mrs. Flora I. Atwood, Townsend.
Royalston, No. 195,	Eri S. Stewart, Athol.	C. E. Richardson, Royalston.	Myron E. Stockwell, Royalston.
Easton, No. 196,	Herbert C. Marshall, R. F. D., North Easton.	H. Leslie Tinkham, R. F. D., North Easton.	Mrs. Emily M. Drew, 11 Grafton St., Brockton.

"Brookville" of Holbrook, No. 197,	Fred Gill, Avon.	Mrs. Alida Gill, Avon.	Miss Edna Bowen, Brookville.
Leominster, No. 198, . . .	James Graves, 258 Main St., Leominster.	Mrs. Ethel Graves, 258 Main St., Leominster.	Chester F. Walker, 974 Main St., Leominster.
Stoughton, No. 199, . . .	E. H. Gilbert, R. F. D., North Easton.	Miss Ella S. Henry, West Stoughton.	Mrs. J. M. Spaulding, West Stoughton.
Uxbridge, No. 200, . . .	Wade B. Phoenix, Uxbridge.	Mrs. Josephine Davis, Millville.	Helen J. Hollis, Uxbridge.
Bridgewater, No. 201, . . .	Roland M. Keith, Bridgewater.	G. W. Cutler, R. F. D. No. 3, Bridgewater.	Alice G. Rhoades, Bridgewater.
Ashburnham, No. 202, . . .	Ernest W. Lawrence, Ashburnham.	Mrs. S. E. Lawrence, Ashburnham.	Mrs. Sadie M. Fosgate, Ashburnham.
Westminster, No. 203, . . .	Hervey W. Bell, R. F. D. No. 1, Westminster.	Cassie E. Black, R. F. D. No. 2, Westminster.	Lizzie E. Baker, R. F. D. No. 1, Westminster.
Rowley, No. 204, ...	Daniel H. O'Brien, R. F. D. No. 1, Rowley.	Miss Minnie I. Blagden, Box 112, Rowley.	John A. Marshall, Rowley.
"Webster" of Marshfield, No. 205,	Walter I. Seaverns, Marshfield.	Mrs. Annie F. Baker, Marshfield.	Frank T. Harlow, Marshfield.
Tewksbury, No. 207, . . .	Neil A. Clark, 65 Commonwealth Ave., Lowell.	Miss Blanche King, Tewksbury.	Mrs. Olive M. Clark, 8 Western Ave., Lowell.
Westford, No. 208, ...	William R. Taylor, R. F. D. No. 1, Westford.	Mrs. Clara Greig, R. F. D. No. 1, Westford.	Mrs. F. C. Wright, R. F. D. No. 1, Westford.
Hanson, No. 209, ...	Arthur W. Gorham, South Hanson.	Mrs. Maud R. Estes, Hanson.	Mrs. Nan S. Harley, Hanson.
Chicopee, No. 211, ...	Clinton G. Chapin, 165 Chicopee St., Chicopee.	Miss Bertha Morehouse, Willimansett.	Harold J. Baldwin, 143 Chicopee St., Chicopee.
"Oak Hill" of Attleborough, No. 212.	H L. Clark, Park St., Attleborough.	Mrs. Aphia G. Carpenter, 15 Park St., Attleborough.	Mrs. M. P. Smith, Locust St., Attleborough.
"Massapoag" of Sharon, No. 213, .	Sidney P. Hull, Sharon.	Elmer M. Johnson, Sharon.	Mrs. Georgie B. Brown, Sharon.
Walpole, No. 214, ...	Dr. Thos. M. Proctor, Walpole.	Wm. J. Wheeler, East Walpole.	Mrs. Carrie C. Snyder, Box 372, Walpole.
Mattapoisett, No. 215, . . .	Dr. Walter E. Blaine, Box 251, Mattapoisett.	Mrs. Evelyn R. Tilden, Box 266, Mattapoisett.	Miss Ella A. Madden, Box 234, Mattapoisett.
Dracut, No. 216, ...	Bert A. Cluff, R. F. D. No. 2, Lowell.	Mrs. Margaret Sarre, 537 Merrimack St., Lowell.	Clifford Harvey, R. F. D. No. 3, Lowell.
Norton, No. 218, ...	Howard F. Woodward, Norton.	Allison J. Cowles, Norton.	Miss Nellie H. Lincoln, East Norton.
East Princeton, No. 219, . .	Van Aldrich, East Princeton.	Mrs. Clare Gates, East Princeton.	Mrs. Alwilda Drury, Princeton.
Sunderland, No. 220, . . .	Wm. P. Abbey, Sunderland.	Ralph B. Brown, Sunderland.	Miss Ruth I. Clark, Sunderland.
"Anawan" of Rehoboth, No. 221, .	Frank L. Thomas, Rehoboth.	Mrs. Jennie C. Smith, Rehoboth.	Mrs. Elmie G. Fuller, Rehoboth.
Tyngsborough, No. 222, . .	Murray Parrish, Tyngsborough.	Mrs. Georgia M. Queen, North Chelmsford.	Norman R. Sherburne, Tyngsborough.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

NAME.	MASTER.	LECTURER.	SECRETARY.
Billerica, No. 223,	James A. Ruth, North Billerica.	Mrs. Forest F. Collier, Billerica.	Josiah C. Folsom, Billerica.
Sheffield, No. 224,	Zaccheus H. Cande, Sheffield.	Geo. A. Scott, Sheffield.	Frank E. West, Sheffield.
Williamsburg, No. 225,	John A. Breckenridge, Williamsburg.	Mrs. Chas. H. Church, Williamsburg.	Luther H. Warner, Florence.
West Medway, No. 226,	James B. Beers, West Medway.	Mrs. Alice D. Esten, West Medway.	Mrs. Annette Hayward, West Medway.
Heath, No. 227,	E. W. Payne, Heath.	Mrs. W. R. Hitchcock, Dell.	E. P. Dickinson, Heath.
Salisbury, No. 228,	Geo. E. Dow, Salisbury.	George O. Rodan, Amesbury.	Miss Leota L. Stevens, Salisbury.
Cochituate, No. 229,	Alexander A. Holmes, Cochituate.	Sidney Loker, Cochituate.	Gertrude D. Bishop, Cochituate.
Taunton, No. 230,	Jesse P. Smith, 210 Scaddings St., Taunton.	Mason Marvel, Worcester St., Taunton.	Geo. A. Hart, 206 County St., Taunton.
"Ponkapoag" of Canton, No. 231,	Miss I. C. McIntyre, 168 River St., Mattapan.	Walter W. Shaw, Ponkapoag.	Miss Mary R. Swett, 1378 Washington St., Canton.
Plainfield, No. 232,	Ralph E. Floyd, Plainfield.	Mrs. E. S. Floyd, Plainfield.	Mrs. Chas. Dunham, Plainfield.
Lexington, No. 233,	Edwin W. Hutchinson, Blossom St., Lexington.	George F. Reed, Parker St., Lexington.	Mrs. E. M. Hutchinson, Blossom St., Lexington.
Newbury, No. 234,	C. Stanley Harrison, East High St., Newbury.	Ethel L. Chase, Curzon Mill Rd., Newburyport.	Marcia E. Little, 4 Green St., Newburyport.
Oakham, No. 235,	John Dwelly, Oakham.	Mrs. Lilla Robinson, Oakham.	Miss Sara E. Butler, Oakham.
"Quascacunquen" of Byfield, No. 236.	Geo. W. Noyes, Byfield.	Harold L. Bailey, Byfield.	Orin D. Steele, Byfield.
Groveland, No. 237,	Matthew N. Currier, 504 Groveland St., Haverhill.	Everett A. Smith, R. F. D. No. 1, Georgetown.	Miss M. Lottie Tuttle, 149 Main St., Groveland.
Bradford, No. 238,	Arthur Barteau, Bradford.	Miss Elizabeth Hunt, 25 Washington Sq., Haverhill.	Mrs. Grace F. Pierce, 4 New St., Bradford.
North Reading, No. 239,	Fred A. Childs, North Reading.	Stanley W. Nichols, North Reading.	Mrs. Blanche W. Burditt, North Reading.
Palmer, No. 241,	F. L. Jones, Palmer.	Mrs. Bessie M. Pelton, Monson.	Mrs. Effie J. Freeman, R. F. D. No. 1, Palmer.
Rutland, No. 242,	Louis M. Hanff, Rutland.	Mrs. Sarah J. Munroe, Rutland.	Mrs. Frances P. Hanff, Rutland.

Enfield, No. 243,	Miss Jennie P. Dodge, Enfield.	Miss Dora Foley, Enfield.	Mrs. Grace T. Moore, Enfield.
Chelmsford, No. 244,	F. L. Lupien, Chelmsford.	Percy Yarnold, 73 Jeness St., Lowell.	Harlan E. Knowlton, Chelmsford.
Greenwich, No. 245,	Colman F. Tyler, R. F. D. No. 2, Ware.	Mrs. L. M. Bishop, Greenwich.	Mrs. J. E. Lincoln, Greenwich Village.
West Stockbridge and Alford, No. 246.	E. A. Easland, R. F. D. No. 1, State Line.	Mrs. N. F. Bailey, R. F. D. No. 1, State Line.	A. R. Hensel, R. F. D. No. 1, State Line.
"Harmony" of Easton, No. 247,	J. Elmore Goss, Easton.	Mrs. Edith Pierce, R. F. D., South Easton.	Mrs. Jennie M. Goss, Easton.
Wendell, No. 248,	Lewis Bowen, Wendell.	Mrs. Mary Glidden, Wendell.	Mrs. Bessie Stafford, Wendell.
Baldwinsville, No. 249,	George H. Smith, Otter River.	James E. Coleman, Otter River.	Ernestine M. Smith, Otter River.
Everett, No. 250,	Thomas E. Carter, 89 Congress St., Malden.	Miss W. Whitcomb, 4 Glendale Pl., Everett.	C. E. Dinslow, 116 High St., Everett.
West Tisbury, No. 251,	James F. Adams, West Tisbury.	Mrs. Evelyn M. Adams, West Tisbury.	Frederick G. Vincent, West Tisbury.
"Wachusett" of Leominster, No. 252.	J. Henry Johnson, 408 West St., Leominster.	Mrs. Jennie E. Vinton, 20 Maple Terrace, Worcester.	Mrs. Emma L. Hatstat, Union St., Box 304, Leominster.
Halifax, No. 253,	Anson A. Anderson, Halifax.	Mrs. Lucy Harlow, 19 Oak St., Middleborough.	Mrs. Nettie Simpson, Halifax.
Shirley, No. 254,	A. A. Adams, R. F. D., Shirley.	Miss Elsie M. Holden, Shirley.	Miss Margaret Evans, R. F. D., Shirley.
Chilmark, No. 255,	Henry H. Allen, Chilmark.	Mrs. Belle Look, Chilmark.	Mrs. Leona M. Vincent, Chilmark.
New Salem, No. 256,	Fred F. Ballard, Millington.	Miss Ruth P. Ballard, New Salem.	Mrs. Maude Flagg, New Salem.
Rochester, No. 257,	Benj. F. Hodgsdon, R. F. D., Marion.	Annie B. Cowen, Rock.	Alberta H. Gerrish, R. F. D., Marion.
Carlisle, No. 258,	Herbert A. Lee, Bedford.	Mrs. Nettie O. Wilson, Carlisle.	Grace H. Chamberlin, Carlisle.
Acton, No. 259,	Wm. H. Kingsley, Acton.	Mrs. Nelson H. Tenney, South Acton.	Miss Ella L. Miller, North Acton.
Dennis, No. 260,	Gerald Chapman, Dennis.	Frank E. Howes, Dennis.	Nathan Crowell, East Dennis.
East Charlemont, No. 261,	O. J. Hager, East Charlemont.	Miss Edna Roberts, East Charlemont.	Mrs. Frank Clark, East Charlemont.
Braintree, No. 262,	George M. Mosher, Braintree.	Joseph E. Hayden, South Braintree.	Mrs. Salome C. Sanford, South Braintree.
Danvers, No. 263,	George D. Hooper, 67 Wenham St., Danvers.	Elmer E. Allen, 270 Newbury St., Danvers.	Loring B. Goodale, 90 Centre St., Danvers.
"Quinobequin" of Medway, No. 264.	Mrs. Eva Mason, Medway.	Mrs. Minnie B. Upton, Medway.	Mrs. Cynthia C. Allbee, Medway.
Great Barrington, No. 265,	Leonard R. Miller, Great Barrington.	Frank A. Minkler, Great Barrington.	Charles T. Kellogg, Great Barrington.
Peru, No. 266,	Wm. H. Cullitt, Peru.	Mrs. Mary Hadlock, Peru.	- - -
"Hill Top" of Windsor, No. 267,	Charles D. Galusha, Windsor.	Mrs. D. A. Cady, Dalton.	Rev. P. H. Abercrombie, Windsor.
Wilmington, No. 268,	Charles F. Perry, Wilmington.	Mrs. Helen H. Buck, Wilmington.	Mrs. Francene A. Morse, Wilmington.
"Mill River" of New Marlborough, No. 269.	A. Lincoln Terry, Southfield.	Mrs. Jessie Spooner, New Marlborough.	Wm. S. Bradley, Southfield.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Concluded.*

NAME.	MASTER.	LECTURER.	SECRETARY.
South Weymouth, No. 270,	William J. Rudkin, Union St., Rockland.	John E. Inkley, 678 Pleasant St., East Weymouth.	Miss M. L. Chandler, 29 Curtis Ave., South Weymouth.
Milford, No. 271,	Fred S. Wilcox, South Milford.	Wm. P. Greenwood, Milford.	Mrs. Minnie B. Wilcox, South Milford.
Brewster, No. 272,	Francis H. Perry, Brewster.	Rev. E. S. Cotton, Brewster.	Mrs. Lilly M. Tubman, North Brewster.
Shutesbury, No. 273,	Mrs. Minnie M. Tenny, Shutesbury.	Mrs. Bessie Moore, Shutesbury.	Mrs. Margaret Haskell, Shutesbury.
Westwood, No. 274,	Ernest F. Schesemeyer, Westwood.	Mrs. C. M. E. White, Westwood.	Miss Carrie L. Mylord, Westwood.
Westhampton, No. 275,	Francis A. Loud, Westhampton.	Mrs. Edwin B. Clapp, Westhampton.	George E. Clapp, R. F. D. No. 2, Northampton.
"Ware Valley" of Ware, No. 276,	Herbert T. Barnes, District No. 2, Ware.	Mrs. Ella Winslow, District No. 7, Ware.	W. Winslow Gibbs, R. F. D., Ware.
Plympton, No. 277,	Winthrop Fillebrown, R. F. D. No. 2, Bryantville.	Mrs. Maud L. Dunne, Silver Lake.	Miss Nellie F. Sherman, Plympton.
Gill, No. 278,	Frank D. Jones, Turners Falls.	Mrs. Frank P. Grant, Gill.	Dan'l Van Vakenburgh, Gill.
Newburyport, No. 279,	Herbert E. Dodge, 12 Harris St., Newburyport.	Luella D. Gore, Turkey Hill Road, Newburyport.	Joshua L. Chase, 25 Forrester St., Newburyport.
"Pocasset" of Bourne, No. 280,	Robert S. Handy, Cataumet.	Mrs. Lena F. Fuller, Cataumet.	Miss Elsie M. Stratton, Cataumet.
Vineyard Haven, No. 281,	Wm. E. Macomber, Vineyard Haven.	Mrs. Annie M. Flanders, Vineyard Haven.	Mrs. Lizzie P. Walker, Vineyard Haven.
Waltham, No. 282,	Charles J. R. Cahill, Beaver St., Waltham.	George W. Patriquin, Beaver St., Waltham.	Miss J. W. Graham, 61 Adams St., Waltham.
Bedford, No. 283,	John R. Comley, Bedford.	Abbott R. Webber, Bedford.	Mrs. Mary E. Laws, Bedford.
East Bridgewater, No. 284,	Ralph D. Seymour, R. F. D., East Bridgewater.	J. Howard Miller, R. F. D. No. 1, Whitman.	Charles D. Meservey, R. F. D. No. 1, Whitman.
Acushnet, No. 285,	Dr. Joel P. Bradford, Acushnet Station, New Bedford.	Mrs. Myra F. Parker, Long Plain, Acushnet.	John Gaggatt, Jr., Long Plain, Acushnet.
West Gloucester, No. 286,	Walter F. Lufkin, West Gloucester.	Miss Lou E. Low, Gloucester.	Alex. W. Andrews, West Gloucester.
Woburn, No. 287,	George J. Whithed, Woburn.	Hadley F. Higgins, Woburn.	Mrs. Lottie A. Greene, Woburn.
Duxbury, No. 288,	Harry W. Priest, Millbrook.	LeRoy M. Peterson, Millbrook.	Miss Leona T. Peterson, Millbrook.

Yarmouth, No. 289,	Thomas S. Crowell, Yarmouthport.	Henry C. Davis, Cummaquid.	Gorham Pulsifer, Yarmouthport.
Norwood, No. 290,	Clement H. Hallowell, Norwood.	Chas. O. Littlefield, Norwood.	Warner H. Holbrook, Norwood.
Monterey, No. 291,	Andrew J. Hall, Monterey.	Mrs. A. J. Hall, Monterey.	Arthur S. Barnum, Monterey.
Saugus, No. 292,	Elmer B. Newhall, 74 Whiting St., Lynn.	Mrs. Addie Reese, Saugus.	John G. Holmes, 124 Main St., Saugus.
Wakefield, No. 293,	Edwin C. Miller, 18 Lawrence St., Wakefield.	E. Horace Perley, 190 Main St., Wakefield.	Mrs. Ida F. Miller, 18 Lawrence St., Wakefield.
Georgetown, No. 294,	Leon S. Gifford, R. F. D., Georgetown.	Mrs. Clara E. Illsley, R. F. D., Rowley.	Miss Alice P. Thayer, R. F. D., Georgetown.
Stockbridge, No. 295,	Peter I. Adams, Housatonic.	Mrs. F. W. Heath, Interlaken.	S. Albert Noble, Stockbridge.
Millers Falls, No. 296,	Harry D. Towne, Millers Falls.	Mrs. Francis Pickett, Millers Falls.	Frederic L. Pomeroy, Millers Falls.
Hamilton-Wenham, No. 297,	Clarence E. Johnson, Hamilton.	Robert Robertson, South Hamilton.	Horace E. Andrews, South Hamilton.
Boxford, No. 298,	Hiram N. Towne, Boxford.	Mrs. Abbie N. C. Perley, R. F. D. No. 2, Georgetown.	Miss Bertha Perley, Boxford.
Hingham, No. 299,	George H. Downing, Hingham Center.	Arthur Hersey, Hingham.	Bertram L. Blanchard, Box 43, Hingham Center.
Ayer, No. 300,	Henry W. Robbins, Ayer.	Mrs. Margaret Rand, Ayer.	Chester P. Perrin, Ayer.
Whitman, No. 301,	George H. Day, 1075 Washington St., Whitman.	Mrs. Grace I. Day, 1075 Washington St., Whitman.	Miss G. M. Lawrence, 19 North Washington St., Whitman.
Pembroke, No. 302,	Norbert Foerster, R. F. D., Bryantville.	Prof. Fred J. Simmons, Pembroke.	Louis A. Sherman, Pembroke.
Weston, No. 303,	Edward P. Ripley, Weston.	- -	Joseph R. Roberts, Weston.
Whately, No. 304,	Montville Crafts, Whately.	Miss Genevieve Pease, East Whately.	Howard R. Waite, Whately.

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TWENTY-FOURTH ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

PART I.,

BEING PART III. OF THE FORTY-NINTH ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

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TWENTY-FOURTH ANNUAL REPORT

OF THE

Massachusetts Agricultural Experiment Station

Part I.

DETAILED REPORT OF THE EXPERIMENT STATION.

INTRODUCTION.

In accordance with the provision of the act of the Legislature relative to the publication of the reports of the Massachusetts Agricultural College, the report of the experiment station, which is a department of the college, is presented in two parts. Part I. contains the formal reports of the director, treasurer and heads of departments, and papers of a technical character giving results of research work carried on in the station. This will be sent to agricultural colleges and experiment stations and to workers in these institutions as well as to libraries. Part I. will be published also in connection with the report of the Secretary of the State Board of Agriculture and will reach the general public through that channel. Part II. will contain papers of a popular character, and will be sent to all those on our general mailing list as well as to agricultural colleges and experiment stations, to workers in these institutions and to libraries in Massachusetts.

WM. P. BROOKS,
Director.

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MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE,

AMHERST, MASS.

TWENTY-FOURTH ANNUAL REPORT.

Part I.

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Harold L. Frost.
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Miss Jessie V. Crocker, Stenographer, Department of Botany and Vegetable Pathology, Sunderland.
Miss Bridie O'Donnell, Stenographer, Department of Entomology, Hadley.

REPORT OF THE DIRECTOR.

Changes in Staff.

During the past year there have been no changes in the more important positions in the experiment station staff. A number of our younger assistants, however, have resigned for various reasons, among which the offer of higher salaries, plans to pursue graduate studies, or to engage in business are among the more prominent. The changes in detail are as follows: —

Sumner C. Brooks, B.Sc., assistant in botany, replaced by Edward A. Larrabee, B.Sc.; Joseph F. Merrill, B.Sc., assistant in plant and animal chemistry, resigned; Clement L. Perkins, B.Sc., assistant in plant and animal chemistry, resigned; David W. Anderson, B.Sc., graduate assistant in department of horticulture, resigned, this position still being vacant. Erwin S. Fulton, B.Sc., assistant agriculturist, resigned, his position being taken by Edwin F. Gaskill, B.Sc., promoted. Charles M. Damon, observer in the meteorological department, replaced by R. N. Hallowell.

The position of second assistant agriculturist has not been filled, but instead the position of secretary to the director has been created. This position has been filled by the appointment of Herbert J. Baker, B.Sc., a recent graduate of the Massachusetts Agricultural College. This change has made possible a sharper division between outdoor and office work, Mr. Gaskill taking charge of the former, while Mr. Baker takes charge of the books, attends to routine correspondence, assists the director in preparation of material for publication, as well as in many other directions.

Two of our most experienced and valuable stenographers, Miss Brown and Miss Cobb, have resigned during the year, their places being taken by Mrs. Church and Miss Felton.

Lines of Work.

There have been no important changes in the general character of station work during the year, although in scope and amount it constantly increases. It includes general experiments both on the home grounds and at substations as well as in co-operation with farmers, research, police or control work, and dissemination of information.

General Experiments.

In order to give a general idea of the nature of the work which is being carried on I cannot do better than to quote a statement in the last annual report: —

> Under this head are included a large number of experiments relative to the following subjects: soil tests with fertilizers, with different crops in rotation; comparisons of different materials which may be used as sources, respectively, of nitrogen, phosphoric acid and potash for different field and garden crops; the results of the use of lime; systems of fertilizing grass lands, both mowings and pastures; comparisons of fertilizers for both tree and bush fruits; different methods of applying manures; variety tests of field and garden crops and of fruits; trials of new crops; determinations of the digestibility of feed-stuffs; methods of feeding for milk; systems and methods of management in feeding poultry for eggs; and co-operative work with selected farmers in the trial of crops and systems of fertilizing them.

In addition we have two substations where work of a highly diversified character is being carried on, viz., asparagus substation in Concord and cranberry substation in Wareham. In later pages will be found brief reports on the work in these substations, while a short account of the results of our co-operative experiments with alfalfa will be found in Part II. of this report.

No full general account or discussion of experimental work in progress will be given. Brief reports on some of the general experiments will be found under the departments in which they are being prosecuted.

Research.

The research work in progress at the station is, for the most part, carried on under the Adams fund. The work during the past year along certain lines has been somewhat interrupted owing to the necessity of making extensive additions and im-

provements in our chemical laboratory. These improvements were, however, very carefully planned and executed under the general supervision of Dr. J. B. Lindsey and his associates, and the extent to which they were allowed to interfere with the progress of laboratory work was, on the whole, surprisingly small.

The following are the principal Adams fund problems which at present engage our attention: —

1. To determine the principles which should underlie practice in the use of fertilizers for the cranberry crop.

2. To determine the principles which should underlie practice in the use of fertilizers for asparagus.

3. Work in plant breeding in the endeavor to produce more rust-resistant types of asparagus. (In co-operation with the Bureau of Plant Industry, United States Department of Agriculture.)

4. Investigation of the solubility effect of ammonium sulfate on the soil of one of our experimental fields. (Field A.)

5. The effect of food on the composition of milk and butter fat and on the consistency or body of butter.

6. The cause of the digestion depression produced by molasses.

7. Why insecticides burn foliage.

8. The relations of climate to development of plants and crops both in health and disease.

9. The causes of calico or mosaic disease as affecting especially the tobacco and the tomato.

10. Malnutrition of plants; causes and prevention.

11. The intensity and amount of sunshine as affecting disease of plants.

12. The causes of winter-killing.

13. Determination of physiological constants.

14. Plant breeding, especially with peas, beans and squashes, to determine the extent to which the Mendelian laws appear to govern heredity.

15. The relations of climate to variation in leading varieties of apples.

16. The economic importance of digger wasps in relation to agriculture.

17. Color vision in bees.

A number of these lines of investigation are well advanced, though none can be regarded as brought to completion. Sufficient progress has, however, been made in connection with a number of them to warrant publication, and technical papers covering some phases of this work will be found in later pages. The more important are as follows: —

The natural fertility of cranberry bogs.

Tobacco injury due to malnutrition or overfertilization.

Variation, correlation and heredity in garden peas.

The effect of fertilizer on variation in corn and beans.

The chemistry of arsenical insecticides.

Cranberry Substation.

Dr. H. J. Franklin remains in local charge of the business and investigational work connected with our cranberry substation. He has devoted himself to the matters in his charge with the greatest faithfulness and enthusiasm, and it is a pleasure to testify to the great value of his services.

During the past year our equipment for work in the interests of cranberry growers at the substation in East Wareham has been much increased and a large amount of construction work has been done. The principal improvement made has been the erection of a building. This building contains a large screening and packing room, living and office rooms for the local officer in charge, a small laboratory, and large basement and cellar storage rooms. The cost of the building was about $2,000.

Dr. Franklin furnishes the following description of special construction at the station bog completed during the year: —

1. *Flooding Areas.* — Five separate areas were diked off on the station bog for experiments in flooding. Four of the areas contain about one-fifteenth of an acre each and the fifth contains about an eighth of an acre. These areas are all separated from each other by dikes and narrow check strips. The dikes were built of turf and sand in the usual way, and average about 20 inches in height and 3 feet in width. In all, about 1,100 running feet of this diking was built. A canal, about 450 feet long and 3 feet wide, was constructed around the margin of the

bog, and connected with the main flooding canal in order to flow and drain these areas. Short side canals were dug to connect this canal with the separate areas. Small canals were also dug to connect the check strips with this canal system. In these various canals 13 wooden flumes were built for controlling the water.

2. *Skinner System Installation.* — On the station bog at East Wareham two lines, 70 and 100 feet long, respectively, of ¾-inch galvanized piping were installed, 60 feet apart, after the usual manner of Skinner system installation. The longer line was supported at intervals by concrete posts of sufficient height to allow a man to walk beneath the piping without stooping. The other line was hung in rings suspended from a wire cable drawn taut between two concrete posts. Both of these methods of support have disadvantages. In the former the concrete posts are too numerous and too heavy to give good satisfaction on the usually soft bottom of a cranberry bog. In the latter it is hard to get rid of a certain amount of sag in the piping, which makes proper pipe drainage difficult in freezing weather. Probably a better method than either of these would be to support the piping on wooden posts reaching up only a foot or two from the surface of the bog, and placed close enough together to prevent the pipe from sagging perceptibly. Skinner "Outdoor No. 2" nozzles were used in this installation. The water for running the system was pumped from Spectacle Pond by means of a Myer's pump driven from the big engine used in flooding the bog. It was arranged to pump this water through 350 feet of 1¼-inch galvanized piping before it reached the Skinner unions, leading into the ¾-inch pipe lines. This 1¼-inch pipe was, for the most part, buried in the ground. A special device driven by water pressure, for turning the pipes back and forth so as to throw the water on both sides, was also installed. The piping in the pump house was arranged to provide for heating the water by pumping it first through the cooling jacket of the 40 horse-power Fairbanks-Morse engine, and then through a coil in the exhaust pot of the engine.

For this installation, the Skinner Irrigation Company, Troy, O., through the courtesy of its president, Mr. W. H. Coles, pro-

vided nozzles and Skinner unions and loaned the station a Skinner drilling machine.

The small piece of upland referred to in the last report as desirable in order to give better access to our building has been purchased during the year.

The Crop of 1911.

The yield of fruit on the station bog during the past year was in round numbers 850 barrels of berries. These were sold for the sum of $4,988.33. The ordinary running expenses for the season amounted to $1,817.08. The bog, therefore, yielded a net income over and above ordinary running expenses of $3,171.25.

The crop of the season was probably better than the average crop will be, and it sold for good prices. We can hardly anticipate so large a net income annually, but there would seem to be no question that the product of the bog will be sufficiently large to furnish a considerable share of the funds that will be needed for paying the costs of experimental work.

Principal Lines of Cranberry Work.

Three principal lines of investigation with cranberries are in progress. These relate respectively to the fertilizer requirements of the crop, the relations of insects to the cranberry industry, and the study of injurious fungi.

Fertilizer Experiments.

The fertilizer experiments in Red Brook bog at Waquoit have again given indecisive results. These experiments will be discontinued. We have found it exceedingly difficult to care for them properly on account of their distance from our center of operations, and we are convinced, moreover, that certain natural inequalities in the character of the bog soil in the different plots must always considerably reduce the value of the results obtained.

During the past season a new series of plots has been laid out in the station bog. The results of the season do not show a well-defined benefit following from the use of either of the

different fertilizers employed. The crop where nitrate of soda is applied, indeed, showed a small average decrease. Both acid phosphate and high-grade sulfate of potash show a very small average increase, — not in either case enough to cover the cost of the fertilizer material applied. The results of the year, therefore, do not lend encouragement to the belief that the use of fertilizers on bogs of as good productive capacity as that belonging to the station will be followed by a profitable increase in the crop. It is important, however, to point out that the application of fertilizers this season was not made until about the middle of July. It seems probable that this is too late for the best results.

Dr. H. J. Franklin furnishes the following report concerning some of his principal lines of investigation during the past two years: —

Cranberry Investigations, 1910.

I. INSECTS.[1]

Of the important cranberry pests heretofore known, those which received attention were the fruit worm, the fire worm and the cranberry girdler.

The Fruit Worm (*Mineola vaccinii* (Riley)).

Experiments in submerging cocoons containing larvæ of this insect, for varying lengths of time during the fall of 1909 and winter and spring of 1910, were carried on without very satisfactory results, due, perhaps, to failure to perfectly imitate natural bog conditions.

Spraying experiments were also carried on, the insecticides used being mostly combinations of adhesives and arsenicals. The combination found most effective consisted of the following mixture in 50 gallons of water: —

	Pounds.
Resin fish-oil soap,	4½
Bordeaux mixture: —	
(*a*) Stone lime,	4
(*b*) Copper sulfate,	3
Paris green,	1

As the soap had adhesive and spreading qualities, and the Bordeaux mixture gave body to the combination and also acted to some extent as an adhesive, this combination spread over the smooth surface of

[1] Dr. H. T. Fernald has aided Dr. Franklin in the insect work in an advisory way, and for his helpful suggestions Dr. Franklin acknowledges his indebtedness and expresses his appreciation.

the partly grown berries and adhered to it much better than did any arsenical with water alone. In this mixture, Paris green seemed to give better results than arsenate of lead. Best results were obtained by spraying twice with an interval of at most only a few days between the two applications, the first application thus acting as a basis for putting a thicker coating of poison on the fruit than would be possible with one spraying alone. This spraying was done about July 20 on berries of a late variety on a strictly dry bog (*i.e.,* no winter flowage). The fruit at this time varied greatly in size, the largest berries being nearly half grown. On some plots the fruit worm injury was reduced as much as 60 per cent.

The Fire Worm (*Eudemis vacciniana* (Pack.)).

The work with this insect consisted entirely of spraying experiments. In the spring, arsenicals alone and in combination with Bordeaux mixture and resin fish-oil soap were tested as insecticides for the larvæ. It became evident that an insecticide of good sticking properties was needed for this purpose as the new foliage of the cranberry is smooth and glossy and holds the water sprays very poorly. Furthermore, this new growth develops rapidly during the time of the hatching of the first brood, and sometimes this hatching period is strung out for fully a month. The experiments indicated that a combination of Bordeaux mixture, Paris green and resin fish-oil soap, like the one given above for the fruit worm, would be most effective for this insect also. One test with this combination showed about three-fifths as much arsenic present on the foliage, after an all day's rain followed by a complete ten-hour flooding, as was present when the spray was first applied. The material for this combination is about as cheap as the arsenate of lead capable of doing the same work. The work connected with its preparation, however, is considerable.

Late in the fall, the value of scalecide and commercial lime-sulfur, as insecticides for destroying the eggs of this insect, was tested. Several plots were sprayed with different strengths of each of the two insecticides mentioned. On some plots a plank drag was used in advance of the spraying to turn the vines over, in order better to allow the spray to reach the lower surfaces of the leaves (on which the eggs are usually laid). The results of this spraying were observed early in June, 1911. Though many eggs hatched on all the plots, it was evident that on those treated with scalecide, a large percentage had been destroyed. However, on all plots on which many of the eggs were killed by the treatment, a large percentage of the winter buds were destroyed also. The fire worm injury appeared to be considerably worse on the plots which had been sprayed with the lime-sulfur than on unsprayed portions of the bog, though the reason for this was not apparent. This method of treatment does not appear promising.

Cranberry Girdler (*Crambus hortuellus* (Hübner)).

The work with this insect was confined to applying different depths of sand to infested plots, to find out what depth was necessary to smother the insect and prevent the moths from coming through. The sand was applied evenly, late in May, to depths varying from 1 to 3 inches. Means for catching and counting the moths which came through the sand on the various plots were provided. An unsanded check plot was also placed under observation and control. No moths came through the sand on any of the sanded plots, while a large number were captured from the check plot. Future work may show that less than a full inch of sand, when evenly spread, is sufficient. However, an inch is not too much to be practicable, especially as the vines are usually heavy where this insect becomes troublesome. To be effective, this treatment must be applied between December 1 and the following June 1 (when the insect is in its cocoon under the vines), and the sand must be spread evenly.

A New Pest.

During 1910 a Lepidopterous insect, known to science as *Gelechia trialbamaculella* Chambers, did great injury to a few strictly dry bogs. Neither the food plant nor the life history of this insect had been heretofore known. Its habits and life history were largely worked out during the season. The insect passes the winter in the moth state, as does the yellow-headed cranberry worm (*Peronea minuta* Robinson), and its larvæ, though considerably smaller, resemble somewhat the larvæ of that insect, both in general appearance and in habits. It is heavily parasitized, and will probably never do noticeable injury on winter-flowed bogs.

II. FUNGI.

The 1910 fungus work, done in co-operation with the Bureau of Plant Industry, consisted in obtaining the assistance of certain of the cranberry growers in practical spraying experiments, and in collecting specimens for examination by Dr. C. L. Shear, the expert of the Bureau of Plant Industry.

Investigations during 1911.

During 1911 the cranberry investigation work was divided between experiments and observations and construction work for future investigations.

Experiments and Observations.

This work came under the seven following heads, viz: Insects, Fertilizers, Fungous Diseases, Weather Observations, Fertilization of the Cranberry Blossom, Prolificness of Varieties, and application of Skinner Irrigation System to the Needs of the Cranberry Industry. The work under these heads is here outlined: —

1. *Insects.*

Observations were continued and experiments conducted with the fruit worm and the fire worm (black-headed cranberry worm). Numerous growers treated the yellow-headed cranberry worm (or, as it might be called in Massachusetts, the dry-bog fire worm), under advice given out by the station, apparently with universally satisfactory results. Heavy sanding done by various growers, in some cases, proved successful against the cranberry girdler. In others it failed to give satisfaction, the failure in every case observed being due to the fact that the sand was not applied evenly over the infested areas.

The Fruit Worm (*Mineola vaccinii* (Riley)). — Work was begun on the natural enemies of this insect, with the following objects in view: —

1. To find out what these enemies are.
2. To determine their relative abundance on flowed and dry bogs.

Spraying experiments with arsenicals and adhesives were continued. It was learned that too much resin fish-oil soap had been used in 1910. While the spraying was not timed so as to give the best results, the experience of 1911 indicates that the following formula will be found more satisfactory than the one given as the result of the 1910 experiments: —

Resin fish-oil soap (pounds),	2
Bordeaux mixture: —	
(*a*) Stone lime (pounds),	5
(*b*) Copper sulfate (pounds),	2½
Paris green (pound),	1
Water (gallons),	50

Much more of the soap than is here recommended causes bad clogging of nozzles and pumps.

While the fruit worm injury was reduced about one-third, this gain was largely offset by the loss due to tramping on the vines and berries while spraying, so that the amount of fruit obtained from the sprayed plots was but little greater than that picked from equal areas on the surrounding bog.

The Fire Worm (*Eudemis vacciniana* (Pack)). — The season's observations on this insect seem to indicate that the character of the vine growth has a strong influence on the length of the hatching period of the spring brood. Among thin vines most of the eggs seem to hatch within a few days after hatching begins. With deep, dense vines, this period seems to be so drawn out that numerous eggs are always present throughout the year, the two broods overlapping in this stage. If these observations are correct, the character of the

vine growth must have an important bearing on the efficacy of both flowing and spraying treatments. In practice, it seems to be an easy matter, on a thinly vined bog, to control this insect sufficiently to keep it from doing serious injury, either by spraying with arsenate of lead or by flowing, while it is apparently impossible to prevent serious injury on a densely vined bog by either of these treatments. The control of this insect, therefore, seems to hinge on the acquirement and maintenance of a thin vine growth, which is also the most desirable condition for maximum crops. Unfortunately, it seems difficult to get a thin vine growth on some bogs. However, this can probably be readily accomplished in most cases, at least, by heavy sanding and proper adjustment of water conditions. This adjustment might be along either or both of the following distinct lines: —

1. Early withdrawal of winter flowage with no long-continued reflowage.
2. Sufficient drainage.

Experiments to test the methods of controlling this insect, here suggested, have already been started. Observations seem to show that large bogs, when compact (*i.e.*, approaching a circle or square) in general form, are, other conditions being the same, much more troubled with this insect than are small ones. Probably the chief reason for this is the fact that, during the summer, parasitic and predacious insects and spiders do not become so thoroughly distributed over the large bogs, at least until the periods of fire-worm activity are nearly over, and so do not become to so great an extent a controlling factor. On a winter-flowed bog, most of these forms are probably either destroyed or driven ashore by the flooding every year. They should not, during the summer, become as uniformly distributed on a large, compact bog as on a small one for two reasons, viz.: —

1. The distance which the parasitic and predacious forms must go to reach the central portion of the bog is, of course, greater on a large bog.
2. As the area from which these forms come onto the bog is probably restricted, for the most part, to a fringe at most only a few hundred feet wide, the area of the bog as it increases in size, if it is compact in shape, increases out of proportion to the increase of the area of this fringe. This argument agrees well with the following previously reported observations: —

1. The fire worm is only very rarely, if ever, troublesome on strictly dry bogs in Massachusetts.
2. When a winter-flowed bog becomes infested the infestation first noticed is always some distance away from the upland, usually where the winter flowage is deep.

The fact that, on a compact bog, there is a larger acreage within a given distance of any point, up to a distance that would take in the

whole bog, than there is on a long, narrow one of equal acreage, may also be, to some extent, a factor in favor of this insect. If it gained a foothold on one portion of such a compact bog, it would more readily and quickly spread to all other portions.

It seems probable, from the various observations made, that if a large bog, round or squarish in shape, is by any means whatever entirely freed from this insect (even by burning or by long-continued summer flowage), it will not, as a rule, long remain so if all the following conditions are allowed to exist: —

1. Winter flowage, especially if it is deep, over a considerable portion of the bog.
2. Not more than one reflowage after the 25th of May.
3. Conditions favoring heavy vine growth.

New Pests. — During the season two new insect pests did considerable injury in some localities on cranberry bogs. One of these is a scale insect (*Aspidiotus oxycoccus* Woglum) which superficially resembles the San José scale somewhat but is very distinct from that species. This species did much injury on a bog in Yarmouth and was noted in smaller numbers in a few other places.

The other insect is a species of white grub (*Lachnosterna* sp.). It caused the dying of circular areas on several bogs, principally in Carver, these patches varying in diameter from 3 to 30 feet. This injury observed superficially might easily be mistaken for the "ringworm" injury caused apparently by fungous disease.

2. *Fungous Diseases.*

This work, as during the previous season, was done in co-operation with the Bureau of Plant Industry. Co-operative spraying experiments were carried on by several practical growers. In addition 3 plots on the station bog, each 4 rods square, were sprayed with fungicides and the results noted, as shown by the quantity and keeping quality of the fruit obtained. The amount of fruit gathered from these plots in every case was somewhat less than that from checks marked on the surrounding bog. This was due, apparently, to the injury done by tramping on the vines while spraying. Loss due to decay up to December 4 was reduced, on an average, about one-half by the treatment. One plot was sprayed three times and the others twice with mixtures and on dates as follows: —

Fungicide.	Plots.				
	A.	B.	C.	D.	E.
Bordeaux mixture,	June 22, July 17	July 17	July 17	July 17	July 18
Neutral copper acetate,	August 2	August 2	August 2	August 3	August 3

The Bordeaux mixture was made up with 3 pounds of lime and 4 of copper sulfate to 50 gallons of water. One pound of the neutral copper acetate was used to 50 gallons of water. Two pounds of resin fish-oil soap were used with the Bordeaux mixture in all cases and with the acetate.

3. *Weather Observations.*

The weather instruments were installed on May 15, from which date until October 15 observations were taken every morning at the station at East Wareham, and records of the following made: —

Maximum thermometer in shelter.
Maximum thermometer on bog.
Minimum thermometer in shelter.
Minimum thermometer on bog.
Precipitation.
Wind direction.
Continuous thermograph readings.
Continuous barograph readings.

The readings of the maximum and minimum thermometers and the amount of precipitation were telegraphed to the local office of the Weather Bureau at Boston every morning after May 15 during the spring and fall periods of frost danger.

4. *Fertilization of the Cranberry Blossom.*

Numerous experiments were carried out and observations made on the cross-fertilization of the cranberry blossom. Bees of all kinds were shut out from half a square rod of vines, during the blossoming period, by means of a mosquito-netting tent, with the result that only about 2⅔ quarts of berries developed, while on any equal area on the surrounding bog as much as 20 quarts were picked, the average crop of the entire bog being about 70 barrels to the acre. From a check plot of equal area laid off close to this tent 28 quarts were gathered. Another larger tent was erected and the honey bee alone allowed to enter it during the bloom, a hive being placed so as to open into it. Under this tent as good a crop developed as on the surrounding bog. These experiments seem to prove that bees are necessary to the satisfactory cross-pollination of the cranberry blossom and that the honey bee is efficient in this work.

As the vines approached full bloom under the tent from which the bees were excluded the blossoms quite generally began to take on a peculiar vivid pink color, and as the blossoming advanced this became more and more striking. Only a small percentage of the blossoms on the bog outside of the tent took on this color, while inside there were few which did not show it strikingly. This tent was on Early Black vines. The tent into which honey bees were admitted was placed on

Howe vines. This variety came to full bloom in the midst of a period of unusually hot weather in July, and had a larger percentage of the pink blossoms than did the Early Blacks which blossomed earlier. The vines under the tent, into which the honey bees were admitted, had a very noticeably smaller proportion of these pink blossoms than did the surrounding bog. They were, in fact, almost entirely absent. These observations seemed to indicate that the peculiar pink color of the bloom was a sign of fertilization failure. This pink coloring certainly always accompanies lack of fertilization with the Early Black variety, for it was just as noticeable in a 1910 experiment, in which bees were shut out by mosquito netting, as it was in the 1911 experiment. To make this matter more certain a large number of Howe blossoms, showing this pink coloring, were marked with yarn and examined late in August. Hardly 2 in 11 had succeeded in producing berries. This was less than one-half of the proportion of berries to blossoms on the bog as a whole. In other words, a much smaller proportion of pink blossoms than of normally colored ones produced berries, thus confirming the indications obtained from the tent experiments. To go with this there is the possibility that fertilization may take place to some extent, though abnormally retarded, after a blossom has taken on the pink color.

After the unfertilized blossoms turned pink in the tent experiments the corolla always hung on abnormally, so that the vines under the tent, from which bees were excluded, appeared to be in full bloom when, on the surrounding bog, the bloom was almost entirely past.

The conclusion arrived at, from these and other observations, is that it will often pay to keep honey bees near cranberry bogs during the blossoming season. There are, undoubtedly, years in which this practice will not repay anything for the extra labor and expense involved. It is probable, however, that it will pay well to keep bees in any season in which wild bees are scarce, or in which there is much bad weather during the blossoming period to reduce the length of time in which the bees can work. Unfortunately, we have not yet sufficient data to make an estimate of the number of hives necessary for the satisfactory pollination of a bog of any given acreage.

With most varieties, an upright having 5 blossoms will probably, as a rule, produce as many berries, if only 2 of those blossoms are cross-fertilized, as it would if all were fertilized. This is because the cranberry, in common with other plants, always produces the means of reproduction far in excess of what it uses. This is borne out by the fact that the crop of berries under the hive-bee tent was not greater than on the surrounding bog, though the lack of pink blossoms seemed to indicate a more perfect pollinization.

5. *Prolificness of Varieties.*

Examination of a considerable number of varieties on numerous bogs showed a marked variation, between varieties, in the average number of berries borne by the individual upright and in the proportion of berries to blossoms. Moreover, this variation seemed, to a certain degree, constant for the different varieties wherever found, even when they were side by side on the same bog and under the same conditions. Some varieties averaged less than 2 berries, and others more than 3, to the upright. Then, too, there was a noticeable varietal variation in the proportion of sterile uprights present. This condition of things obviously is not due to relative lack or abundance of pollen-carrying agents (bees), or to differences in fertility of the bottom on which the vines grow, but is the result of a varying quality of natural prolificness in the vines themselves.

During the season, work was begun with the idea of eventually producing, if possible, a much more prolific variety than any at present known. A large number of uprights of three different varieties were selected and marked for planting in separate plots in the spring. Only uprights were marked which produced during the season 4 or 5 good berries. It will be observed that this is in line with similar work already carried out successfully with corn, potatoes and other crops.

6. *Skinner System of Irrigation.*

This plant has been installed to test thoroughly the value of this system as applied to the following needs of a dry cranberry bog: irrigation, frost protection, winter protection and possibly spraying. This system is not expected to supplant water supply by other methods in vogue, where these methods are available. Late in the fall, the feasibility of heating the water so as to raise the temperature by radiation, without sprinkling over the entire surface of the bog, was tried. It was thought that the amount of piping and the size of the pump necessary in practice might in this way be reduced. The tests, however, showed this to be impracticable.

Asparagus Substation, Concord.

Mr. Charles W. Prescott, to whose hearty interest, enthusiasm and efficient supervision we are greatly indebted, has continued in charge of the details of the work in progress.

Two distinct lines of investigation are being carried on: —

1. Breeding experiments which have for their object the production of a rust-resistant type of asparagus of good commercial quality.

2. Fertilizer experiments planned with a view to determining if possible the relation of different fertilizer elements to the crop as regards yield, quality and capacity to resist rust.

Breeding Experiments. — The breeding work in progress is conducted on the basis of a co-operative understanding with the Bureau of Plant Industry of the United States Department of Agriculture. The details of the work have been looked after the past season by Mr. J. B. Norton, who has carried it forward with the same enthusiasm and energy which has characterized his work heretofore.

A number of rust-resistant types have been produced. From among these those which show the best commercial characteristics and the greatest vigor will be propagated as rapidly as possible for further trial and ultimate distribution. In view of the great improvement already made it is confidently anticipated that complete success in attaining the ends in view will soon be realized.

Fertilizer Experiments. — The results of the fertilizer experiments in progress are not as yet sufficiently decisive to make it seem advisable to publish a full report. Owing to the thorough preparation which the entire field received before it was divided into plots, even those to which no manure or fertilizer has been applied still continue to give an excellent yield. These plots, however, are now beginning to fall behind those which receive the different applications of manure and fertilizer materials which are under trial. The field contains 40 plots of one-twentieth acre each, and the past season was the fifth since the plots were set. The yield was fairly satisfactory both as to quantity and to quality. The cutting season lasted from May 8 to June 24. The total yield of all the plots was 9,347 pounds, 5 ounces.

On the basis of recorded yields and observations the following conclusions appear to be warranted: —

1. Nitrate of soda used in connection with acid phosphate and muriate of potash proves beneficial, but an increase above the rate of 466 pounds per acre does not appear to be useful.

2. Nitrate of soda used in connection with an application of barnyard manure at the rate of 10 tons per acre proves benefi-

cial, but in this case, also, an increase above the rate of 466 pounds per acre of nitrate is not followed by a further increase in the crop.

3. Nitrate of soda has been applied according to three distinct plans: —

(*a*) All applied in early spring.

(*b*) One-half applied in early spring and the balance at the close of the cutting season.

(*c*) All at the close of the cutting season.

These variations in method of applying have been tried with nitrate of soda in differing amounts and in varying combinations.

The variation in season of application is not followed by any well-defined difference in yield, but the amount of rust has appeared to be less with the larger applications applied at least in part after the cutting season. In other words, nitrate of soda so applied and in such liberal quantities as to promote a continuous vigorous growth of the plant after the close of the cutting season seems to increase the capacity of the plants to resist rust.

4. Among the different materials used as the source of potash, viz., muriate, high grade sulfate, low grade sulfate, wood ashes, and kainit, the plot receiving the latter showed the least rust. It is important, however, to point out that this may have been in part a consequence of the fact that the plot was located on the side of the field lying at the greatest distance from the fields which are believed to have been the chief sources of rust infection. The comparative freedom from rust of the plants on the kainit plot, therefore, may have been due in large measure to location. The decided difference, however, in the amount of rust on this plot and on the one immediately adjoining it, the location of which with reference to rust infection is not very different, lends probability, at least, to the conclusion that the kainit exercised a favorable influence in preventing rust.

5. Acid phosphate used in connection with nitrate of soda and muriate of potash has given a considerable increase in crop. This increase is greatest where the acid phosphate is used at the maximum rate of 188.7 pounds per acre.

6. Muriate of potash used in connection with nitrate of soda

and acid phosphate increases the crop, but an increase in the quantity of muriate above the rate of 260 pounds per acre does not result in further increase in the crop.

Control Work.

Reports in full detail covering the various lines of control work carried on by the station have been prepared by the chemists in charge. These will be found in later pages of this report.

Fertilizer Law. — The fact was pointed out in the last annual report that a new law had been drafted for presentation in the Legislature of 1911. This law was enacted by the Legislature and went into effect Dec. 1, 1911. The new law is working smoothly and satisfactorily. It is bringing in the increased revenue needed for more thorough work, and the principal change introduced, viz., bringing agricultural lime under its provisions, is proving of much value to our farmers.

Dairy Law. — The draft for a new dairy law referred to in the last annual report failed of enactment in the Legislature of 1911. It will be reintroduced in the Legislature of 1912, and it is confidently anticipated that it will be enacted. The most important change from the existing law consists in bringing milk inspectors, and the Babcock machines and apparatus which they use, under the provisions of the law.

Feed Law. — The fact was referred to in the last annual report that the appropriation received from the State for carrying out the provisions of the existing feed law were proving insufficient to cover the costs of thorough work. During the past year a draft for a new law has been prepared. Its preparation has involved a great deal of study and many conferences with parties affected by the law. The principal changes proposed are to bring the various wheat offals under the provisions of the law, to require a guarantee of the maximum percentage of crude fiber present, to require the statement of ingredients contained in each feeding stuff, and to require the registration of each brand of feeding stuff before it is sold. The amount of the appropriation provided under the new draft is $6,000 in place of $3,000 as under the present law. Besides these changes the phraseology has been made more explicit, violations are

more clearly defined, and the director is given discretionary power regarding prosecutions.

In form and general content the new draft has been closely modeled after the uniform feed law adopted by the Association of Feed Control Officials of the United States. It is believed that the provision of a uniform feed law for the entire country is desirable in the interests alike of the buying public and manufacturers and dealers.

Dissemination of Information.

The station endeavors to reach the public with helpful information in three rather distinct lines: distribution of publications, private correspondence, and lectures and demonstrations.

Publications. — The station issues three classes of publications: an annual report in two parts, bulletins and circulars.

Part I. of our annual report contains the formal reports of the director, treasurer, and heads of departments and technical papers giving the results of research work. Part II. contains papers of a more popular character. It is our aim to include in this part of the report such matters as are of most immediate interest on the farm.

The demand for bulletins and circulars constantly increases. With the further growth and development of the extension department of the Massachusetts Agricultural College it is expected that this demand will be increasingly met by means of its publications, while our own publications will be, for the most part, restricted to such as deal with the results of our investigations. It must be recognized that satisfying this popular demand is extension work rather than experimental.

The following tables show the publications of the year 1911 and those of that and earlier years which are still available for free distribution: —

Publications during 1911.

Annual report: —

Part I., 356 pages; Part II., 95 pages.

Bulletins: —

No. 136. Inspection of Commercial Feed Stuffs, P. H. Smith and C. L. Perkins. 56 pages.

No. 137. The Rational Use of Lime, Wm. P. Brooks; The Distribution, Composition and Cost of Lime, H. D. Haskins and J. F. Merrill. 19 pages.
No. 138. Tomato Diseases, George E. Stone. 32 pages.
No. 139. Inspection of Feed Stuffs, P. H. Smith and C. L. Perkins. 32 pages.
No. 140. Inspection of Commercial Fertilizers, H. D. Haskins, L. S. Walker, J. F. Merrill and R. W. Ruprecht. 86 pages.

Circulars: —

No. 30. Balanced Rations for Dairy Stock, J. B. Lindsey. 7 pages.
No. 31. Lime and Sulphur Solutions, G. E. Stone. 4 pages.
No. 32. An Act to regulate the Sale of Commercial Fertilizers (chapter 388, 1911). 4 pages.

Meteorological bulletins, 12 numbers. 4 pages each.

Publications Available for Free Distribution.

Bulletins: —

No. 33. Glossary of Fodder Terms.
No. 64. Concentrated Feed Stuffs.
No. 76. The Imported Elm-leaf Beetle.
No. 84. Fertilizer Analyses.
No. 90. Fertilizer Analyses.
No. 115. Cranberry Insects.
No. 123. Fungicides, Insecticides and Spraying Directions.
No. 125. Shade Trees.
No. 127. Inspection of Commercial Fertilizers.
No. 130. Meteorological Summary — Twenty Years.
No. 131. Inspection of Commercial Fertilizers, 1909.
No. 132. Inspection of Commercial Feed Stuffs, 1910.
No. 133. Green Crops for Summer Soiling.
No. 134. The Hay Crop.
No. 135. Inspection of Commercial Fertilizers, 1910.
No. 136. Inspection of Commercial Feeds, 1911.
No. 137. The Rational Use of Lime.
No. 138. Tomato Diseases.
No. 139. Inspection of Commercial Feed Stuffs, 1911.
No. 140. Inspection of Commercial Fertilizers, 1911.

Index to bulletins and annual reports of the Hatch Experiment Station previous to June, 1895.

Index to bulletins and annual reports, 1888–1907.

Circulars: —

No. 12. The Unprofitable Cow and how to Detect her.
No. 20. Lime in Massachusetts Agriculture.
No. 25. Cottonseed Meal.
No. 26. Fertilizers for Potatoes.

No. 27. Seeding Mowings.
No. 28. Rules Relative to Testing Dairy Cows.
No. 29. The Chemical Analysis of Soils.
No. 32. An Act to regulate the Sale of Commercial Fertilizers.
Summer Soiling Crops.
Home-mixed Fertilizers.
Dairymen losing Money on Low-Grade Feeds.
Balanced Rations for Business Cows.
Orchard Experiment.
Fertilizers for Turnips, Cabbages and Other Crucifers.
Fertilizers for Corn.
Annual reports: 10th, 12th, 13th, 14th, 15th, 16th. 17th, 20th; 21st, Part II.; 22d, Parts I. and II.; 23d, Parts I. and II.

Circulation of Publications. — As provided by act of our Legislature, Part I. of our annual report is printed with the report of the secretary of the State Board of Agriculture, and those on the mailing list of that Board will receive this publication. The act provides, also, that 5,000 copies of Part I. shall be furnished to the station. These are used in supplying libraries and directors of agricultural experiment stations, libraries and presidents of agricultural colleges, the public libraries of Massachusetts and other public libraries on our mailing list, individuals on the mailing list of the United States Department of Agriculture, and institutions and periodicals on our exchange list.

The State prints an edition of 16,000 copies of Part II. of our annual report for the use of the station. This part of the report and our bulletins are sent to all those on our general mailing list, to the public libraries of the State, to individuals on the mailing list of the United States Department of Agriculture likely to be interested, and to experiment stations and the agricultural colleges.

It is our practice to reserve a considerable number of each publication to meet subsequent demands, but such demands have of late been so numerous that our supply of most of our earlier editions is exhausted.

Our meteorological bulletins are sent only to agricultural college and experiment station libraries, presidents and directors of agricultural colleges and experiment stations, to the depart-

ment of agriculture and office of experiment stations, to newspapers and libraries and to individuals who have especially requested them.

The circulars which we issue are not sent out to a regular mailing list. They are prepared for use in connection with the correspondence of the station, for it is by the use of such circulars only that we find it possible to give the full information and advice needed by those consulting us by letter. Any of these circulars, however, will be sent on special request.

The newspapers of the State receive an abstract of all important publications, and as a rule we find them ready to publish such abstracts.

Mailing Lists. — A large amount of work is required in keeping our mailing lists accurate and thoroughly alive. We are constantly dropping names and as constantly adding new ones. The tendency is towards an increase, although just at present our total is a few hundred less than shown in the last annual report, owing to the fact that some lists not previously revised for a number of years have undergone very careful revision resulting in dropping a number of addresses which had undoubtedly been for some time dead. The following table shows the nature of the lists which we maintain and the number of addresses in the several classes: —

Residents of Massachusetts,	12,651
Residents of other States,	2,438
Residents of foreign countries,	242
Newspapers,	518
Libraries,	306
Exchanges,	151
Cranberry growers,	1,395
Beekeepers,	2,866
Meteorological,	389
Total,	20,956

Correspondence. — During the year 1911 the number of letters of inquiry answered by members of the station staff has been about 12,000. This is a somewhat smaller number than

for 1910. It is apparent that the public in increasing degree is recognizing that the extension department is especially manned and equipped for service of this character, and it would seem, therefore, that we may confidently anticipate still further relief from this work in the near future, — a consummation long wished for, as it will give station men more time for the more legitimate station work of research and experiment.

Lectures and Demonstrations. — The public demand for lectures and demonstrations has been particularly active, and station men have been frequently engaged in service of this character. The general management and arrangements are, for the most part, looked after by the extension department, but even under this plan the draft upon the time of some of our men has been so heavy as to leave little opportunity for attention to experiment or research. This has been particularly true of the men in our poultry and apicultural departments, which are greatly in need of additional men in order that the requirements of both lines of work — extension and research — may be more fully met.

Buildings.

Extensive improvements and repairs have been made during the year in the chemical laboratory of the station at a cost of $7,500, appropriated by the last Legislature. The following are the principal improvements secured: two additional rooms for research work; enlarged office room; greatly increased space for storage of apparatus, chemicals and samples; a fire-proof vault; and a library and reading room. Central steam heat has been introduced in place of the independent hot-water system. Numerous minor repairs have been made and the entire building has been replumbed, rewired and repainted. As a consequence of the various changes and improvements the building now fairly satisfies the needs of the chemical department of the station, but the chemical work increases so rapidly that it cannot be many years before additional laboratory accommodations will be needed.

There has been but one other important building operation during the year, — the erection of the building at the cranberry

substation in East Wareham, already mentioned and briefly described in the report on the work at that substation. The cost of the building (about $2,000) was nearly covered by an unexpended balance of the $15,000 appropriation made by the Legislature in 1910.

WM. P. BROOKS,
Director.

REPORT OF THE TREASURER.

ANNUAL REPORT

Of Fred C. Kenney, Treasurer of the Massachusetts Agricultural Experiment Station of the Massachusetts Agricultural College.

For the Year ending June 30, 1911.

The United States Appropriations, 1910–11.

	Hatch Fund.	Adams Fund.
Dr.		
To receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1911, under acts of Congress approved March 2, 1887 (Hatch fund), and March 16, 1906 (Adams fund),	$15,000 00	$15,000 00
Cr.		
By salaries,	$13,269 05	$11,659 35
labor,	321 49	1,079 94
publications,	8 50	–
postage and stationery,	2 89	51 44
freight and express,	–	–
heat, light, water and power,	1 38	170 47
chemicals and laboratory supplies,	31 74	137 54
seeds, plants and sundry supplies,	478 69	356 20
fertilizers,	542 04	75 27
feeding stuffs,	196 35	1 46
library,	–	7 53
tools, machinery and appliances,	–	4 50
furniture and fixtures,	61 75	50 00
scientific apparatus and specimens,	86 12	1,343 17
live stock,	–	–
traveling expenses,	–	18 13
contingent expenses,	–	–
buildings and land,	–	45 00
Total,	$15,000 00	$15,000 00

State Appropriation, 1910–11.

Cash balance brought forward from last fiscal year,	$4,198 48	
Cash received from State Treasurer,	13,500 00	
fertilizer fees,	6,239 83	
farm products,	2,068 85	
expert services,	25 00	
miscellaneous sources,	9,601 69	
		$35,633 85
Cash paid for salaries,	$9,875 92	
labor,	10,342 73	
publications,	2,443 03	
postage and stationery,	982 42	
freight and express,	407 18	
heat, light, water and power,	579 55	
chemicals and laboratory supplies,	636 97	
seeds, plants and sundry supplies,	2,507 67	
fertilizers,	350 99	
feeding stuffs,	1,548 98	
library,	451 10	
tools, machinery and appliances,	69 50	
furniture and fixtures,	408 79	
scientific apparatus and specimens,	649 06	
live stock,	44 00	
traveling expenses,	2,303 89	
contingent expenses,	250 00	
buildings and land,	895 17	
balance,	866 90	
		$35,633 85

REPORT OF THE AGRICULTURIST.

WM. P. BROOKS.

As has been the case for many years, the problems which have chiefly engaged the attention of the department of agriculture during the past year are such as are connected with the selection, adaptations, and methods of application of manures and fertilizers. In most cases a definite and uniform plan of experiment has been followed for a considerable number of years. The work will not be reported in detail, but attention is called to a few of the more striking results.

I. Comparison of Different Materials as a Source of Nitrogen (Field A).

The different materials under comparison are manure, one plot; nitrate of soda, two plots; dried blood, two plots; and sulfate of ammonia, three plots. In the case of both nitrate of soda and dried blood one of the two plots receives muriate as a source of potash; the other, high-grade sulfate. The sulfate of ammonia is used on two plots in connection with muriate, and on one in connection with sulfate of potash. The field contains three no-nitrogen plots, on two of which muriate is used as a source of potash; on the other, high-grade sulfate. All the plots in the field receive an equal liberal application of dissolved bone black as a source of phosphoric acid, while all the different materials furnishing either nitrogen or potash are used on the different plots in such amounts as to furnish, respectively, equal quantities per plot of nitrogen and of potash.

The crops grown in this experiment in the order of their succession have been: oats, rye, soy beans, oats, soy beans, oats,

soy beans, oats, oats, clover, potatoes, soy beans, potatoes, soy beans, potatoes, oats and peas, corn, clover for four years and corn.

The corn crop of the past season made an excellent growth, but was rather seriously injured by an exceptionally early and severe frost on September 13. So serious was the injury that it was deemed best to allow the crop to stand until the ears were thoroughly dry. It is believed that the proportion of sound corn obtained by following this plan was greater than it would have been had the crop been cut and shocked in accordance with the usual custom.

On the basis of 100 for nitrate of soda, the relative standing of the different nitrogen fertilizers and the no-nitrogen plots as measured by total yield during the past season was as follows: —

	Per Cent.	
	Grain on Cob.	Stover.
Nitrate of soda,	100.00	100.00
Barnyard manure,	98.20	100.00
Sulfate of ammonia,	101.41	98.25
Dried blood,	101.58	101.58
No nitrogen,	95.67	108.06

The relative standing of the different materials as indicated by total yield for the twenty-two years during which the experiment has continued is as follows: —

	Per Cent.
Nitrate of soda,	100.00
Barnyard manure,	94.26
Dried blood,	92.80
Sulfate of ammonia,	87.53
No nitrogen,	73.04

In making up the table on relative standing for the twenty-two years the grain only for 1911 was included, as, owing to the manner in which the crop was handled, there had been breakage and waste from the frost-bitten stalks and leaves, the amount of which was not uniform for the different plots.

On the basis of increase as compared with the no-nitrogen plots the relative standing for the different nitrogen fertilizers for the twenty-two years is as follows: —

	Per Cent.
Nitrate of soda,	100.00
Barnyard manure,	78.71
Dried blood,	73.29
Sulfate of ammonia,	53.74

It will be noted that nitrate of soda, as in previous years, shows a much greater average increase than either of the other sources of nitrogen.

One of the most striking results of the past season was the relatively large yield produced on the no-nitrogen plots. It amounts to about 95 per cent. of the average yield on all the different plots which have received an application of nitrogen annually. This result, it will be readily understood, was no doubt due to the fact that clover for three years had preceded the corn crop of the past year. The figures emphasize in a most striking way the extent to which rotations including a legume may be made to take the place of the use of nitrogen fertilizers.

II. Muriate as compared with Sulfate of Potash.

These comparisons were begun in 1892. Five pairs of plots are under comparison. From 1892 to 1899 potash salts were used in quantities (varying in different years, but always in equal amounts, on the two members of a pair of plots) ranging from 350 to 400 pounds per acre. Since 1900 the quantity used has been uniform on all plots, and at the rate of 250 pounds per acre annually. The only other fertilizer material applied has been fine-ground bone to each plot at the uniform rate of 600 pounds per acre. The past year is the twentieth year of these experiments. The crops during the year were alfalfa on one pair of plots, clover on one pair, and asparagus, rhubarb and blackberries, each occupying a part of a pair of plots. The rates of yield per acre on the different potash salts are shown in the following table: —

	Rate per Acre (Pounds).				
	Alfalfa.	Asparagus.	Rhubarb.	Blackberries.	Clover.
Muriate of potash, . .	1,627.9	6,181.2	14,128	2,086.5	2,905.4
Sulfate of potash, . .	2,041.4	5,161.6	19,315	5,907.4	3,689.6

It will be noted that the asparagus is the only crop which gives a larger yield on the muriate, and that the superiority of the sulfate is quite marked in the case of each of the others.

There was a characteristic and remarkable difference in the appearance of the alfalfa on the two salts throughout the entire season, that on the sulfate being of a richer, darker green and far more vigorous growth. A similar difference characterized the appearance of the clover on the two salts. In the case of rhubarb the proportion of leaf to stalk, as in previous years, was considerably greater on the sulfate than on the muriate. This appears to be a highly characteristic effect, and is one for which at present we are unable to offer an explanation.

III. Manure alone compared with Manure and Sulfate of Potash.

This experiment has been in progress since 1890. It occupies the south corn acre, which is divided into 4 plots of one-quarter acre each. On two of these plots good barnyard manure from well-fed dairy cows has been applied at the rate of 6 cords per acre. On the other two plots similar manure has been applied, at first at the rate of 3 cords per acre, but since 1895 at the rate of 4 cords per acre, and together with these smaller applications of manure high-grade sulfate of potash at the rate of 160 pounds per acre has been applied. The object in view is to determine the crop-producing capacity of the smaller amount of manure combined with sulfate of potash as compared with that of the larger application of manure.

The general practice has been to apply manure annually, but in a number of instances, when it was feared that if this should be done the newly seeded grass and clover would lodge badly, the customary application has been withheld; but in all cases if withheld from one plot it was of course withheld from all.

The plan of cropping this field for the last thirteen years has been corn and hay in rotation in periods of two years for each. During the past season the crop has been corn. The rates of yield per acre are shown in the following table: —

	Yield per Acre.		
	Hard Corn (Bushels).	Soft Corn (Bushels).	Stover (Pounds).
Plot 1, manure alone,	89.140	2.460	4,780
Plot 2, manure and potash,	85.260	1.430	4,740
Plot 3, manure alone,	88.570	2.230	4,580
Plot 4, manure and potash,	83.490	1.890	4,580
Averages: —			
Plots 1 and 3, manure alone,	88.855	2.345	4,680
Plots 2 and 4, manure and potash,	84.375	1.660	4,660

The crop on all the plots was an excellent one, and it will be noted that the larger application of manure alone gave a yield of hard corn about 4½ bushels greater than that produced on the smaller amount of manure and potash. The combination produced a slightly smaller yield both of soft corn and stover. The difference in crop is not sufficiently great to cover the difference in cost between the two systems of manuring.

IV. Average Corn Fertilizer compared with Fertilizer Richer in Potash.

These experiments are carried on on what is known as our north corn acre, which is divided into 4 one-quarter acre plots. The experiments began in 1891. Continued corn culture was the rule at first, but for the past sixteen years corn and hay, two years of each, have regularly alternated. Two of the plots in the field, 1 and 3, are fertilized with a home-made mixture furnishing nitrogen, phosphoric acid and potash in highly available forms, and in the same proportions in which they are contained in the average corn fertilizer offered on our markets. The other two plots are fertilized annually with a home-made mixture containing much less phosphoric acid and more potash than is applied to the other plots.

The crop of the past season was corn, and it was an excellent one on all plots. The average yields were at the following rates per acre: —

	Hard Corn (Bushels).	Soft Corn (Bushels).	Stover (Pounds).
On the fertilizer rich in phosphoric acid and low in potash, ...	88.66	1.89	4,230
On the fertilizer low in phosphoric acid and rich in potash, ...	86 69	2.02	4,486

The larger proportion of phosphoric acid has evidently been favorable to the production of sound, well-ripened grain.

V. Top-dressing for Hay.

Since 1893 we have been using barnyard manure, wood ashes, and a mixture of bone meal and muriate of potash as top-dressing for permanent mowing. The total area included in these experiments is about 9 acres divided into 3 plots, so that each year each system of top-dressing is represented. The order in which the different materials is applied to any given plot is as follows: barnyard manure; next year, wood ashes; and in the succeeding year a combination of fine ground bone and muriate of potash. The rates of application per acre: —

1. Barnyard manure, ... 8 tons.
2. Wood ashes, ... 1 ton.
3. { Fine-ground bone, ... 600 pounds.
   Muriate of potash, ... 200 pounds. }

The crop of the past year was very much lighter than usual on account of the marked deficiency of rainfall and the extreme heat. The average yield for the entire area this year was at the rate of 3,993 pounds per acre. The yields on the different materials used in top-dressing were at the following rates per acre: —

	Pounds.
Barnyard manure, ...	3,840
Fine-ground bone and muriate of potash, ...	4,304
Wood ashes, ...	3,736

The average yields to date under the different systems of top-dressing have been at the following rates per acre: —

	Pounds.
Barnyard manure,	6,211
Wood ashes,	5,681
Fine-ground bone and muriate of potash,	6,061

Poultry Work.

For a considerable number of years experiments on the best methods of feeding poultry for egg production have been conducted in this department. In the spring of 1911 all poultry work was transferred to the head of the poultry department of the college. There has been so much construction work in this department during the past year, however, in the effort to get it properly established and equipped, that the poultryman has no report to offer at this time.

REPORT OF THE HORTICULTURIST.

FRANK A. WAUGH.

The work in horticulture has gone on during the year on much the same lines as heretofore, but plans have been forming for certain new kinds of work. The work on heredity and variation in peas has developed a considerable mass of data from which publication is made in this report. Certain correlative topics are still under study and will be reported on later.

The work on Mendelism in beans has been going on successfully during the last year. We now have on record full data for about 15,000 plants. It is expected that one or two years further study will be required to bring this subject to the point of publication. Somewhat similar work with squashes is also under way and will be carried forward as fast as opportunity permits. A few minor problems are studied as time and opportunity offers.

The work in apple variation, already reported upon in one or two publications, still progresses. The plan of work now contemplates a more intensive study of variation and its correlation with local climatological factors.

A research experiment in the mutual influence of stock and cion has been planned to extend over a period of twenty years or more. Work has begun on a small scale, but it will probably require another year or two to get the experiment fully under way. The planning and inauguration of this experiment have been chiefly due to the efforts of Dr. J. K. Shaw.

There is a strong demand for experimental work in other lines of horticulture aside from those already taken up at this station. Work is urgently needed in lines of market gardening

and floriculture, and some steps should be taken at once to serve these important and significant industries. For this purpose additional funds should be provided by the State.

All the experimental work herein referred to has been under the direct management of Dr. J. K. Shaw. In order to carry out the work now under way, and other work imperatively needed, it will be very desirable to have an additional assistant within the year.

REPORT OF THE CHEMIST.

JOSEPH B. LINDSEY.

This report gives a brief outline of the work of this department for the year ending Dec. 1, 1911.

1. Correspondence.

There have been sent out substantially 5,500 letters during the year, the estimate being based on the number of stamps used. It is not believed that more than the usual number of letters of inquiry have been received by this department. The increase of 500 over the year 1910 was probably due to the increased correspondence in connection with the control and cow testing work.

2. Numerical Summary of Substances examined in the Chemical Laboratory.

The following substances have been received and examined: 114 samples of water, 527 of milk, 2,799 of cream, 204 feedstuffs, 209 fertilizers and fertilizer refuse materials, 63 soils, 36 lime products, 27 ash analyses of plants and 4 miscellaneous. There have also been examined in connection with experiments in progress by the several departments of the station 116 samples of milk and cream, 57 cattle feeds and 377 agricultural plants. In connection with the control work there have been collected 1,063 samples of fertilizer and 773 samples of feedstuffs. The total for the year was 6,369.

The above does not include the work of the research section. In addition, 15 candidates have passed the examination and

secured certificates to operate the Babcock test, and 4,466 pieces of Babcock glassware have been tested for accuracy, of which only 12 pieces or .27 of 1 per cent. were condemned as inaccurate.

3. Work of the Research Section.

Work has continued along much the same lines as heretofore. It has been considerably impeded, however, by the extensive repairs made to the laboratory during the summer and autumn.

(*a*) Messrs. Holland and Reed have devoted a large amount of their time to the devising of methods for the making of chemically pure insecticides, and have furnished the entomological department with Paris green, acid arsenate of lead and metarsenite of lime. A paper on this work will probably be found elsewhere in this report. Some progress has been made in the quantitative determinations of the insoluble fatty acids, and numerous factors have been studied such as strength of alcohol, ratio of fatty acids to solvent, amount of precipitant, conditions favoring the formation of a crystalline precipitate, etc. This work will be given more attention during the present year.

(*b*) Mr. Morse has continued his studies relative to the effect of fertilizers on asparagus and has brought together a considerable amount of data on the subject. It is not believed, however, that the work is sufficiently advanced to warrant an extended paper on the project. The same chemist has also continued his work with cranberries, devoting his time principally to a chemical examination of the drainage water in the cylinders. These cylinders, it may be stated, are made of large, glazed tile sunk in the earth and filled with peat and sand so as to represent miniature cranberry bogs.

(*c*) Dr. Lindsey has continued his work on the cause of the digestion depression produced by molasses. Butyric acid — a product of carbohydrate fermentation — has been fed to sheep in different amounts, but without apparently causing any noticeable depression. This work is being continued.

Numerous digestion experiments have been made including plain and molasses beet pulp, grain screenings and Creamo feed.

Attention has also been given and experiments are now in

progress relative to calf meal substitutes for milk in rearing dairy calves, and also to the cost of milk production.

Papers relative to the digestibility of cattle feeds and on corn best suited for the silo in Massachusetts will be found elsewhere in this report.

4. Report of the Fertilizer Section.

Mr. H. D. Haskins makes the following report: —

The work of the division has been devoted chiefly to the inspection of commercial fertilizers, although quite a variety of other work has also claimed attention. The collection and analysis of the various brands of agricultural lime sold in the Massachusetts markets was made during the early winter months; these have served in the preparation of a lime bulletin (No. 137), which was published in April. The complete ash analysis of 19 samples of asparagus roots has also been made in connection with the Concord field experiments; analytical work has likewise been completed on 44 samples which was begun during the previous year. Complete ash analyses have been made on 4 samples of corn kernels and 4 samples of corn stover in connection with field experiments conducted by the agricultural department. Considerable work has been done in the study of normal tobacco soils and subsoils in order to obtain comparative data in connection with cases of overfertilization or malnutrition; the analyses will be found in a short article entitled "Tobacco Injury due to Malnutrition or Overfertilization," to be found on later pages in this report. An unusually large amount of time has been devoted to co-operative work in connection with the Association of Official Agricultural Chemists. Work was done on nitrogen and potash, and the writer has served in the capacity of referee on phosphoric acid. The planning of this work, the preparation of the samples to be used by various chemists in obtaining analytical data, and the subsequent preparation of the report presented to the association took both time and energy. As the object, however, is to improve our present methods of analysis, and to introduce new and better methods, the time was unquestionably well spent. The examination of home-mixed fertilizers, refuse by-products

and soils sent on by farmers has been attended to as in the past, and a more detailed report of this portion of the work will be found on a subsequent page.

The work of the collection and analysis of registered fertilizers shows a substantial increase over that of the previous year; in fact, a larger number of commercial fertilizers has been registered, collected and analyzed during the season than for *any previous* year. A new fertilizer law was enacted during the season and went into effect Dec. 1, 1911. The full text of the law is given in Bulletin No. 140.

As a result of co-operative studies made by the experiment stations of New England, New York and New Jersey we have been able this year, for the first time in the history of the fertilizer control work, to publish analytical data as to the character of the organic nitrogen supplied by the various brands sold in the State. The additional work entailed has required the assistance of one extra man during the greater part of the season.

On a few subsequent pages will be found summaries covering the fertilizer control work: —

(*a*) Fertilizers licensed.
(*b*) Fertilizers collected.
(*c*) Fertilizers analyzed.
(*d*) Trade values of fertilizing ingredients.
(*e*) Unmixed fertilizing material.
  (1) Nitrogen compounds.
  (2) Potash compounds.
  (3) Phosphoric acid compounds.
(*f*) Grades of fertilizer.
(*g*) Summary of analyses and guarantees.
(*h*) Quality of plant food.
  (1) Nitrogen.
  (2) Phosphoric acid.
  (3) Potash.
(*i*) Miscellaneous fertilizers, by-products and soils for free analysis.

(*a*) *Fertilizers licensed.*

During the year, 88 manufacturers, importers and dealers, including the various branches of the trusts, have secured certificates for the sale of 492 different brands of fertilizer, agricultural chemicals and raw products in the Massachusetts markets. Inspection fees have been paid on 27 more brands than during the previous year. These brands may be classed as follows: —

Complete fertilizers,	332
Fertilizers furnishing phosphoric acid and potash,	10
Ground bone, tankage and dry ground fish,	53
Chemicals and organic nitrogen compounds,	97
Total,	492

(*b*) *Fertilizers collected.*

The samples were taken by our regular inspector, Mr. Jas. T. Howard, assisted by Mr. E. C. Hall and Mr. E. L. Winn. An effort has been made in all cases to get representative samples. At least 10 per cent. of the bags found present have been sampled by means of an instrument taking a core the entire length of the bag. In no case has there been less than 10 bags of each brand sampled wherever that number has been found in stock. In case of bulky mixed goods, which might have a tendency to mechanical separation in transit, a sample has been taken from both sides of the bag, so that in case any of the fine heavier chemicals, such as potash salts, had sifted through the more bulky portion, the sample taken would be more representative.

Whenever possible, samples of the same brand have been collected in various parts of the State, the object being to sample as large a proportion of the tonnage shipped into the State as possible. In most cases, where duplicate samples have been drawn, a composite made up of equal weights of the various samples served for the analysis. In some instances several analyses have been made of the same brand; this has been done at the request of large consumers who have bought heavy shipments of some special brand.

It is difficult to tell how large a per cent. of the total tonnage shipped into the State has been sampled. An effort was made at the end of the season of 1910 to ascertain approximately the number of tons sold, but some of the larger manufacturers refused to furnish the data. As complete and extensive a collection as possible has been made in the limited time at our disposal and with the means available for the work.

During the season 116 towns were visited and 1,063 samples representing 519 distinct brands were drawn from stock found in the possession of 284 different agents, as against 897 samples and 487 distinct brands collected and examined in 1910. Some of these brands represent private formulas which would have been sent to the station for analysis by the consumer had they not been taken by our inspectors. Arrangements can be made in most cases to have large shipments of private formulas sampled by one of our regular collectors, provided notification is given sufficiently early in the season so that the various places may be visited while the collectors are in that vicinity.

(c) *Fertilizers analyzed.*

Six hundred and sixty-two analyses have been made in connection with the 1911 fertilizer inspection. The analyses made may be grouped as follows: —

Complete fertilizers,	427
Fertilizers furnishing phosphoric acid and potash, such as ashes, etc.,	18
Ground bones, tankage and fish,	73
Nitrogen compounds, including the mineral forms of nitrogen; also the various organic forms, both animal and vegetable,	69
Potash compounds,	50
Phosphoric acid compounds,	25
Total,	662

(d) *Trade Values of Fertilizing Ingredients.*

The following table of trade values was adopted by the experiment stations of New England, New York and New Jersey at a conference held the 1st of March, 1911, and have served as the basis of valuing the fertilizers published in this bulletin. The schedule for 1910 is also given for comparison.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals for 1910 and 1911.

	Cents per Pound.	
	1910.	1911.
Nitrogen: —		
In ammonia salts,	16	16
In nitrates,	16	16
Organic nitrogen in dry and fine-ground fish, meat and blood,	20	23
Organic nitrogen in fine[1] bone, tankage and mixed fertilizers,	20	20
Organic nitrogen in coarse[1] bone and tankage,	15	15
Organic nitrogen in cottonseed meal, castor pomace, linseed meal, etc.,	–	21
Phosphoric acid: —		
Soluble in water,	4½	4½
Soluble in neutral ammonium citrate solution (reverted phosphoric acid),[2]	4	4
In fine[1] ground bone and tankage,	4	4
In coarse[1] bone, tankage and ashes,	3½	3½
In cottonseed meal, linseed meal and castor pomace,	3½	3½
Insoluble (in neutral ammonium citrate solution) in mixed fertilizers,	2	2
Potash: —		
As sulfate, free from chlorides,	5	5
As muriate (chloride),	4¼	4¼
As carbonate,	8	8
In cottonseed meal, castor pomace, linseed meal, etc.,	–	5

The basis for these trade values was the average wholesale quotations of chemicals and raw materials as taken from the commercial publications during the six months preceding March 1, 1911, plus about 20 per cent. They are supposed to represent the average cost per pound for cash at retail of nitrogen, phosphoric acid and potash as found in unmixed fertilizing material in the principal markets in New England and New York. There has been but little change in the cost of the various forms of plant food, with the exception of the better forms of organic nitrogen which have shown a considerable advance as compared with the previous year.

(e) *Unmixed Fertilizing Material.*

Thirty-three samples of ground bone have been collected and analyzed. Ten were found deficient in phosphoric acid and 5 in nitrogen. The average retail cash price for ground bone has been $31.32 per ton, the average valuation $29.80, and the per-

[1] Fine and medium bone and tankage are separated by a sieve having circular openings one-fiftieth of an inch in diameter. Valuations of these materials are based upon degree of fineness as well as upon composition.

[2] Dissolved by a neutral solution of ammonium citrate, specific gravity 1.09, in accordance with method adopted by Association of Official Agricultural Chemists.

centage difference 5.10. Two of the brands analyzed showed a commercial shortage of 50 cents or over a ton.

Eighteen samples of tankage have been analyzed. Three were found deficient in nitrogen and 5 in phosphoric acid. The average retail cash price per ton was $34.14, the average valuation per ton $32.69, and the percentage difference 4.43. Nitrogen in fine tankage has cost on the average 20.89 cents; nitrogen in coarse tankage has cost 15.65 cents per pound. Three samples have shown a commercial shortage of over 50 cents per ton.

Twenty-two samples of dry ground fish have been examined. Three were found deficient in nitrogen and 2 in phosphoric acid. The average retail cash price per ton was $41.90, the average valuation $42.71, and the percentage difference in excess 1.93. Nitrogen from dry ground fish has cost on the average 22.56 cents per pound. None of the brands showed a commercial shortage of over 50 cents per ton.

(1) *Nitrogen Compounds.* — Three samples of sulfate of ammonia have been analyzed and found well up to the guarantee. The average cost of a pound of nitrogen in this form has been 16.78 cents.

Twenty-three samples of nitrate of soda have been analyzed and 3 were found deficient in nitrogen. The average cost of nitrogen in this form has been 16.19 cents per pound.

Four samples of dried blood have been examined which, with one exception, showed overruns in nitrogen. The pound of nitrogen from blood has cost 23.29 cents.

Four samples of castor pomace have been analyzed. The average cost of nitrogen in this form has been 26.11 cents per pound.

Twenty-three samples of cottonseed meal have been examined, all of which were purchased as a nitrogen source for tobacco. Nitrogen from this source has cost on the average 23.08 cents per pound. Six samples have shown a nitrogen deficiency which has, in 3 cases, amounted to 50 cents or more per ton.

(2) *Potash Compounds.* — Twenty-one samples of high grade sulfate of potash have been examined, and the potash guarantee was maintained in all but one instance. The pound

of actual potash in this form has cost on the average 5.2 cents. Two cases of misbranding were discovered by our inspectors. Material put out by the Nitrate Agencies Company as high-grade sulfate of potash proved upon analysis to be muriate of potash. The sale of the material as sulfate of potash was discontinued and the material was properly labeled.

Six samples of potash-magnesia sulfate have been examined and all but 2 were found fully up to the guarantee. The pound of actual potash in this form has cost 5.91 cents. Several cases have been detected where high-grade sulfate of potash has been reduced with sand and kieserit. The parties registering the material have disclaimed any knowledge of such a practice, and state that the material was bought for potash-magnesia sulfate and sold by them in the original bags as imported from Germany. The matter was taken up with the German syndicate, who traced the adulteration back to the mine that originally produced the goods. A statement was made by the importers that the mine had been heavily fined for the practice, and large shipments of the adulterated product had been returned to the mine. The importers offered to compensate the buyers, who in turn would rebate the farmer, for the value of the deficient magnesia less the value of the overrun in potash.

Eighteen samples of muriate of potash have been examined and 3 were found deficient in potash. The pound of actual potash as muriate or chloride has cost on the average of 4.43 cents. Two brands have shown a commercial shortage amounting to 50 cents or over per ton. There seems reason to believe that it is not improbable that some cases of apparent shortage in case of muriate of potash may be due to absorption of moisture, resulting, of course, in a greater weight of the material without any actual loss of potash, provided the material is sold in the original package and each package is only credited with a weight of 200 pounds.

Three samples of kainit have been analyzed and found well up to the guarantee. The pound of actual potash from kainit has cost 4.34 cents.

(3) *Phosphoric Acid Compounds.* — Two samples of dissolved bone black have been analyzed and both showed a commercial shortage of over 50 cents per ton. The pound of avail-

able phosphoric acid from this source has cost on the average 6.11 cents.

Fifteen samples of acid phosphate have been examined and all but 2 were found well up to the minimum guarantee. No commercial shortage of over 50 cents a ton occurred. The pound of available phosphoric acid from acid phosphate has cost 5.44 cents.

Seven samples of basic slag phosphate have been analyzed and all were found well up to the guarantee. The pound of available phosphoric acid from basic slag, as determined by Wagner's method, has cost on the average 5.12 cents.

(*f*) *Grades of Fertilizer.*

The grouping of the complete fertilizers into three different grades furnishes a convenient means of showing the superior advantages to be derived from the purchase of *high-grade fertilizers.* In the tables below the high-grade fertilizers are represented by those brands having a commercial value of $24 or over a ton; the medium grade by those which value between $18 and $24; and the low grade by those which value $18 or less per ton. A table showing average cash price, commercial value, money difference between cash price and valuation, and percentage difference of the three grades of fertilizer follows: —

	High Grade.		Medium Grade.		Low Grade.	
	1910.	1911.	1910.	1911.	1910.	1911.
Average cash price per ton,	$38 40	$40 87	$33 51	$35 08	$27 80	$29 64
Average ton valuation,	$28 81	$28 89	$21 04	$21 04	$15 61	$15 37
Average money difference,	$9 59	$11 98	$12 47	$14 04	$12 19	$14 27
Percentage difference,	33.28	41.47	59.26	66.73	78.08	92.84

Table showing the Average Composition of the Three Grades of Fertilizer.

Grade.	Number of Brands.	Per Cent. of Whole Number.	Per Cent. of Nitrogen.	Per Cent. of Phosphoric Acid.			Per Cent. of Potash.	Pounds of Available Plant Food in 100 Pounds of Fertilizer.
				Soluble.	Reverted.	Available.		
High,	153	46.22	4.12	4.00	3.32	7.32	7.64	19.08
Medium,	103	31.12	2.61	2.93	2.94	5.87	5.12	13.60
Low,	75	22.66	1.66	4.53	2.82	7.35	2.90	11.91

What is shown by the above tables: —

1. That the average ton price for the three grades of fertilizer has been nearly $2 more for 1911 than for the previous year, although but little difference is noticed in the average valuation per ton for the two years.

2. That the percentage excess of the selling price over the valuation in the low-grade fertilizers is about two and one-fourth times more than it is in the high-grade goods, and over one and one-half times more than in the medium-grade fertilizers.

3. That with a 38 per cent. advance in price over the low-grade fertilizer, the high grade furnishes about 88 per cent. increase in commercial value.

4. The average high-grade fertilizer with a 16.5 per cent. advance in price over the medium goods, furnishes 47.6 per cent. more plant food and 37.3 per cent. increase in commercial value.

5. That with a 38 per cent. advance in price over the low-grade fertilizer, the high-grade furnishes more than 60 per cent. increase in available plant food.

6. A ton of the average high-grade fertilizer furnishes 49.2 pounds more nitrogen and 94.8 pounds more of actual potash than does a ton of the low-grade goods.

7. A ton of the average high-grade fertilizer furnishes 30.2 pounds more nitrogen and 50.4 pounds more potash than does a ton of the medium-grade goods.

Table showing the Comparative Pound Cost, in Cents, of Nitrogen, Potash and Phosphoric Acid in its Various Forms in the Three Grades of Fertilizer.

Element.	Low-grade Fertilizer.	Medium-grade Fertilizer.	High-grade Fertilizer.
Nitrogen,	38 6	33.4	28.3
Potash (as muriate),	8.2	7.1	6.0
Soluble phosphoric acid,	8.7	7.5	6.4
Reverted phosphoric acid,	7.7	6.7	5.7
Insoluble phosphoric acid,	3.9	3.3	2.8

This table shows: —

1. That the purchase of high-grade fertilizers in place of low-grade goods has saved over 10 cents on every pound of nitrogen and over 2 cents on every pound of potash and phosphoric acid.

2. That the purchase of high-grade fertilizers in place of medium-grade goods has saved over 5 cents on every pound of nitrogen and over 1 cent on every pound of potash and phosphoric acid.

3. Taking the average analysis of the high-grade fertilizer as a basis, the purchase of the high-grade in place of the low-grade goods would mean a saving of $14.23 on every ton purchased; the purchase of the high-grade in place of the medium-grade would mean a saving of $7.12 on every ton purchased.

4. About 54 per cent. of the number of brands sold in Massachusetts are classed as medium or low-grade fertilizers. Assuming that the tonnage of these goods was as large as for the high-grade brands, there would have been a tremendous saving to the Massachusetts farmer had he bought only high-grade fertilizer.

5. The purchaser of fertilizers should look to the guaranteed analysis and remember that he is buying pounds of plant food as well as tons of fertilizer. He should know the form and about the proportion of the various elements of plant food and should purchase the brand which sells for the least money which comes nearest fulfilling his requirements.

6. Every one should consider and profit by the lessons taught by the above data.

(g) Summary of Results of Analyses of the Complete Fertilizers as compared with the Manufacturers' Guarrantee.

Manufacturers.	Number of Brands Analyzed.	Number with All Three Elements equal to Guarantee.	Number equal to Guarantee in Commercial Value.	Number with One Element below Guarantee.	Number with Two Elements below Guarantee.	Number with Three Elements below Guarantee.
W. H. Abbott,	2	–	1	–	2	–
American Agricultural Chemical Company,	73	30	69	29	14	–
Armour Fertilizer Works,	13	8	13	5	–	–
Atlantic Fertilizer Company,	4	1	3	1	1	1
Baltimore Pulverizing Company,	2	1	2	–	1	–
Beach Soap Company,	6	3	5	1	1	1
Berkshire Fertilizer Company,	8	5	8	2	1	–
Bonora Chemical Company,	1	–	1	1	–	–
C. M. Bolles,	1	1	1	–	–	–
Bowker Fertilizer Company,	32	10	26	16	6	–
Jos. Breck & Sons,	3	3	3	–	–	–
Buffalo Fertilizer Company,	8	4	7	3	1	–
E. D. Chittenden Company,	6	3	5	2	1	–
Clay & Son,	1	1	1	–	–	–
Coe-Mortimer Company,	18	1	12	9	7	1
Eastern Chemical Company,	1	1	1	–	–	–
Essex Fertilizer Company,	11	1	8	9	1	–
C. W. Hastings,	1	–	–	1	–	–
Listers Agricultural Chemical Works,	9	4	9	5	–	–
J. E. McGovern,	1	1	1	–	–	–
Mapes' Formula and Peruvian Guano Company,	20	10	19	8	2	–
National Fertilizer Company,	17	7	14	7	3	–
Natural Guano Company,	1	1	1	–	–	–
New England Fertilizer Company,	7	1	3	3	2	1
New England Mineral Fertilizer Company,	1	1	1	–	–	–
Nitrate Agencies Company,	1	–	1	1	–	–
Olds & Whipple,	6	3	6	3	–	–
Parmenter & Polsey Fertilizer Company,	10	1	5	6	2	1
Patrons' Co-operative Association,	2	2	2	–	–	–
Pulverized Manure Company,	1	1	1	–	–	–
Rogers Manufacturing Company,	9	7	9	2	–	–

(*g*) *Summary of Results of Analyses of the Complete Fertilizers as compared with the Manufacturers' Guarantee* — Con.

Manufacturers.	Number of Brands Analyzed.	Number with All Three Elements equal to Guarantee.	Number equal to Guarantee in Commercial Value.	Number with One Element below Guarantee.	Number with Two Elements below Guarantee.	Number with Three Elements below Guarantee.
Rogers & Hubbard Company,	8	5	7	3	–	–
Ross Bros. Company,	4	1	4	2	1	–
N. Roy & Son,	1	–	1	1	–	–
Sanderson Fertilizer and Chemical Company,	7	6	7	1	–	–
M. L. Shoemaker & Company,	2	1	2	1	–	–
Swift's Lowell Fertilizer Company,	17	7	15	5	5	–
20th Century Specialty Company,	1	1	1	–	–	–
Wm. Thomson & Sons,	2	1	2	1	–	–
Whitman & Pratt Rendering Company,	4	2	4	2	–	–
Wilcox Fertilizer Company,	9	6	9	3	–	–
A. H. Wood & Co.,	3	1	3	2	–	–

The above table shows: —

1. That 334 brands of registered complete fertilizers have been collected and analyzed.

2. That 191 brands (57 per cent. of the total number analyzed) fell below the manufacturers' guarantee in one or more elements.

3. That 135 brands were deficient in one element.

4. That 51 brands were deficient in two elements.

5. That 5 brands were deficient in three elements.

6. That 41 brands (over 12 per cent. of the whole number analyzed) showed a commercial shortage; that is, when the overruns were used to offset shortages they did not show the amount in value of plant food as expressed by the smallest guarantee.

The deficiencies found were divided as follows: —

96 brands were found deficient in nitrogen.
90 brands were found deficient in available phosphoric acid.
66 brands were found deficient in potash.

As compared with the previous year the guarantees have not been as generally maintained. Thirty-six more brands were found deficient in nitrogen and 10 more in available phosphoric acid than for the season of 1910. The brands showing a commercial shortage were 17 more than during the previous year; in many cases, however, the commercial deficiency was small, amounting to less than 25 cents per ton.

Table showing Commercial Shortages (25 Cents or Over) in Mixed Complete Fertilizers for 1910 and 1911.

Commercial Shortages.	Number of Brands.	
	1910.	1911.
Between $1 and $2 per ton,	6	9
Under $1, not less than 25 cents per ton,	18	17

Some brands have suffered serious deficiencies in some element of plant food without showing any commercial shortage, the deficiency being made up by an overrun of some other element. This is due, probably, either to carelessness or poor mixing rather than a disposition to furnish less plant food value than is called for in the guarantee. It furnishes a condition not to be commended, however, as the fertilizer may be rendered seriously out of balance.

(*h*) *Quality of Plant Food.*

(1) *Nitrogen.* — Sixty or more per cent. of the total nitrogen in the average mixed fertilizer is derived from organic sources, and until recently it has not been possible to tell the consumer much concerning its activity or immediate availability. Heretofore there has been published the nitrogen from nitrates and ammoniates as well as the water soluble and water insoluble organic nitrogen. It has seemed evident, however, that some of the brands contained at least a portion of their nitrogen in low-grade forms, but a lack of a suitable method of analysis has rendered it impossible to procure sufficient evidence to definitely substantiate the supposition. In 1910 the chemists in charge of the fertilizer control work in New England, New York

and New Jersey co-operated in an effort to make a careful study of the Jones' modification of the "Alkaline permanganate method" and Street's "Neutral permanganate method" for testing the activity of the water insoluble organic nitrogen in mixed fertilizers. Satisfactory results were obtained with the Jones' modification, which were confirmed on the same samples by means of vegetation experiments conducted at the Rhode Island Experiment Station. The work proved so satisfactory that in March, 1911, the Jones' modification was adopted provisionally by the New England, New York and New Jersey experiment stations.

All of the complete fertilizers reported in this bulletin have, therefore, been tested as to their organic nitrogen activity. Out of a total of 334 brands analyzed, 43 or nearly 13 per cent. of the whole number, have shown an activity of their water insoluble organic nitrogen of less than 50 per cent.

So far as one is able to judge from the analytical data and the explanations furnished, the following facts may be deduced: —

1. Some manufacturers used nitrogen-containing material of a low availability.

2. In some cases it was used as a direct source of nitrogen to bring the material up to its minimum guarantee. In other cases it was used to raise the guarantee above the minimum. In still other cases it was employed as a filler or to improve the mechanical condition of the fertilizer.

3. It is possible that the inactive materials employed were not sufficiently treated to render their nitrogen available.

It is hoped that manufacturers will endeavor to improve conditions another season, for it is believed that the consumer of commercial fertilizers — at least of the better grades — is entitled to receive all of his nitrogen in such an available form as is called for by the 50 per cent. alkaline permanganate standard.

(2) *Phosphoric Acid.* — Many of the fertilizer mixtures contained large overruns in total phosphoric acid, while the available phosphoric acid on the same brands has shown a considerable shortage. This may have been due to incomplete acidulation of the bone or raw mineral phosphate used, or to the addition of considerable unacidulated rock phosphate, bone

or roasted iron or alumina phosphate. Of the total phosphoric acid found in all of the brands analyzed, 84 per cent. was present in available forms. In case of the available phosphoric acid found, 58 per cent. was present in water soluble form.

(3) *Potash.* — As in previous years, the form in which the potash was present has been noted in every fertilizer analyzed. Very few cases have been found showing the absence of chlorides in those brands where sulfate is guaranteed. In the majority of cases, however, the amount of chlorine found present has been so small as to be counted as incidental. A quantitative test, however, has in all cases been made. In case of some of the tobacco brands, quite a considerable quantity of chlorine has been found where carbonate of potash was guaranteed. This would indicate the use of carbonate of potash from the beet sugar industry. The latter material frequently contains as high as 10 to 12 per cent. muriate of potash. It is reasonable to suppose that if the consumer pays for carbonate of potash he expects that the fertilizer will exclude both soluble chlorides and sulfates.

(*i*) *Miscellaneous Fertilizers, By-products and Soils for Free Analysis.*

Including the materials which have been tested for the various departments of the experiment station, there have been received and analyzed 339 different substances. They may be grouped as follows: 209 fertilizers and by-products used as fertilizers, 63 soils, 36 lime compounds, 27 ash analyses of plants and 4 miscellaneous products. Whenever possible, the fertilizer and lime samples have been taken by one of our regular inspectors and by means of the regulation sampling tube. In all other cases the samples have been taken according to printed instructions furnished from this office. In reporting results, information has been furnished as to the best manner of using the material, and in case of soils the rational treatment of the same as regards fertilizers, cultivation and crop rotation. The analyses of most of the lime products appear in Lime Bulletin, No. 137. The analyses of home-mixed fertilizers and private formulas collected by our inspectors will appear in a table by themselves in the fertilizer bulletin. The other analyses mentioned will not be published.

5. Report of the Feed and Dairy Section.

Mr. P. H. Smith submits the following: —

The Feed Law (Acts and Resolves for 1903, Chapter 122).

During the year 733 samples of feeding stuffs have been collected and examined. A regularly employed inspector covers the State at intervals during the year, collects samples and ascertains if the provisions of the law are being complied with. Protein, fat, fiber and in some instances moisture and ash determinations are made. It is a matter of satisfaction to note that practically all feeding stuffs are as represented. This statement should not be interpreted to mean that all feeding stuffs offered are of good quality, but that all articles in the market correspond to the guarantee placed upon them.

Violations of Law. — The principal violation of the law as heretofore has been that local dealers, either through carelessness or through the neglect of shippers to furnish tags, fail to guarantee. The experiment station, through its representative, does what it can to prevent violations of this character. In order that the law may be fully enforced in this respect, the co-operation of consumers is needed. The consumer can be of material assistance by insisting that all feeding stuffs that he purchases, with the exception of wheat by-products and ground whole grains, shall bear the guaranteed analysis together with the name and address of the manufacturer.

It is believed that adulteration is seldom practiced. There are some feedstuffs on the market to which low-grade products are occasionally added. Wheat feeds and hominy feed to which ground corn cobs have been added are of this character. The manufacturers ship these goods with the proper guarantee, but they occasionally reach the consumer with the tags removed. It seems evident that the local dealer is responsible for this, desiring to conceal the real identity of the article. The purchaser should not without careful investigation purchase wheat feeds or hominy feeds that are unguaranteed or that are offered very much below the ruling price.

New Law. — The officers in charge of the feeding stuffs law have felt for some time that the present law was inadequate to

meet present conditions, and this year a new law will be presented to the General Court for its consideration and adoption. The proposed law differs from the present law in the following particulars: —

1. It is modeled as closely as local conditions will permit after the uniform law proposed by the Association of Feed Control Officials.

2. It carries an increase in revenue which is necessary if it is to be satisfactorily enforced. This increase is also made necessary by the increase in number of brands at present on the market.

3. Wheat feeds, now exempt, have been included.

4. It has been so revised as to render it easier of enforcement and more explicit.

The Dairy Law (*Acts and Resolves for 1901, Chapter 202*).

This law requires that all persons who are using the Babcock test as a basis of payment for milk and cream, either in buying or selling, must secure a certificate of proficiency from the experiment station. It also requires that Babcock machines be inspected by an experiment station official annually, and that all glassware used be tested for accuracy by the station.

Chapter 425, Acts and Resolves for 1909, added to the law by giving the director of the experiment station the authority to revoke a certificate if it is found that an operator is using dirty or untested glassware, or if he is doing the work in an improper manner.

The station makes the following suggestions to operators: —

1. Every operator must have a certificate, and no person without a certificate is legally entitled to make the test. The operator may employ a person without a certificate to *aid* him in his work, but he must work with him and be responsible for the working of the machine, and must read the tests in person.

2. Great care should be taken in getting accurate samples. The test from a sample carelessly drawn will not represent the value of the milk or cream from which it is taken, no matter how carefully the testing is done.

3. Cream and curdled samples of milk should be weighed and not pipetted. The only reason that milk or cream is ever pi-

petted is as a matter of convenience and on the supposition that 18 cubic centimeters of cream or 17.6 cubic centimeters of milk will weigh 18 grams. It is difficult and often practically impossible to get exactly 18 grams of sour milk or thick cream with the use of the pipette.

4. In reading the *milk* test include the *entire* fat column. In *cream* tests read from the lowest point of the fat column to the bottom of the upper meniscus or curve. In case of *cream* tests, if the entire fat column is included the reading will be about 1 per cent. too high.

Summary of Dairy Inspection. — During the year 15 candidates have been examined and given certificates to operate the Babcock test. Four thousand, four hundred and sixty-six pieces of glassware have been examined for accuracy and only 12 have been condemned, a smaller percentage than for any preceding year.

Following is a summary for the eleven years the law has been in force: —

Year.	Number of Pieces tested.	Number of Pieces condemned.	Percentage condemned.
1901,	5,041	291	5.77
1902,	2,344	56	2.40
1903,	2,240	57	2.54
1904,	2,026	200	9.87
1905,	1,665	197	11.83
1906,	2,457	763	31.05
1907,	3,082	204	6.62
1908,	2,713	33	1.22
1909,	4,071	43	1.06
1910,	4,047	41	1.01
1911,	4,466	12	.27
Totals,	34,152	1,897	5.56[1]

The testing outfits in 30 creameries and milk depots have been inspected. Nine of these, an exceptionally large number, required reinspection. A machine that vibrates badly, caused

[1] Average.

by worn bearings or an insecure foundation, cannot be expected to do satisfactory work, neither can a machine give a clear separation of fat where the speed is insufficient. A number of operators were found using untested glassware. The director of the experiment station has the right to prosecute the owners of the plant where this is being done, and also to revoke the license of the operator. Thus far this matter has been corrected when called to the attention of the creamery men. Continued violations will, however, make prosecution necessary.

Following is a list of creameries and milk depots visited: —

1. *Creameries.*

Location.	Name.	President or Manager.
1. Amherst,	Amherst,	R. W. Pease, manager.
2. Amherst,	Fort River,[1]	E. A. King, proprietor.
3. Ashfield,	Ashfield Co-operative,	Wm. Hunter, manager.
4. Belchertown,	Belchertown Co-operative,	M. G. Ward, manager.
5. Brimfield,	Crystal Brook,	F. N. Lawrence, proprietor.
6. Cummington,	Cummington Co-operative,	D. C. Morey, manager.
7. Egremont,	Egremont Co-operative,	E. A. Tyrell, manager.
8. Easthampton,	Hampton Co-operative,	W. S. Wilcox, manager.
9. Heath,	Cold Spring,	F. E. Stetson, manager.
10. Hinsdale,	Hinsdale Creamery Company,	W. C. Solomon, proprietor.
11. Monterey,	Berkshire Hills Creamery,	F. A. Campbell, manager.
12. North Brookfield,	North Brookfield,	H. A. Richardson, proprietor.
13. Northfield,	Northfield Co-operative,	C. C. Stearns, manager.
14. Shelburne,	Shelburne Co-operative,	I. L. Barnard, manager.
15. Wyben Springs,	Wyben Springs Co-operative,	H. C. Kelso, manager.

2. *Milk Depots.*

Location.	Name.	President or Manager.
1. Boston,	D. W. Whiting & Sons,	Geo. Whiting.
2. Boston,	H. P. Hood & Sons,	W. N. Brown.
3. Boston,	Boston Dairy Company,	W. A. Graustein.
4. Boston,	Boston Jersey Creamery,	T. P. Grant.
5. Boston,	Walker-Gordon Laboratory,	G. Franklin.
6. Boston,	Oak Grove Farm,	C. L. Alden.
7. Boston,	Maine Creamery Company,	E. H. Smith.
8. Boston,	Turner Center Dairying Association,	L. L. Smith.
9. Boston,	Plymouth Creamery Company,	W. L. Johnson.
10. Cambridge,	C. Brigham Co.,	J. R. Blair.
11. Cheshire,	Ormsby Farms,	W. E. Penniman.
12. Dorchester,	Elm Farm Milk Company,	J. K. Knapp.
13. Sheffield,	Willow Brook Dairy,	F. B. Percy.
14. Southborough,	Deerfoot Farm Dairy,	S. H. Howes.
15. Springfield,	Tait Bros.,	Tait Bros.
16. Springfield,	Emerson Laboratory,	H. C. Emerson.

[1] Pays by test. Testing done at Massachusetts Agricultural Experiment Station.

Milk, Cream and Feeds for Free Examination.

With certain restrictions the resources of the experiment station are available to residents of Massachusetts who desire information relative to the composition of milk, dairy products and cattle feeds. When necessary, samples taken in accordance with the directions furnished will be analyzed free of cost. On account of the large amount of data on file, it is often possible to furnish the information desired without recourse to analysis. The experiment station will not undertake to act as commercial chemists, and, on account of the limited funds at its disposal, must use its own discretion as to what samples it will analyze.

Water Analysis.

The station has analyzed 114 samples of water. All probably came from private water supplies. Public water supplies are under the charge of the State Board of Health, and all matters pertaining to such supplies should be referred to them. Of the 114 samples received 80 were from wells, 30 from springs and 4 were taken from ponds.

The results show that farm wells situated near buildings are quite susceptible to pollution and may become sources of infection for typhoid fever and other bacterial diseases, while springs situated at a distance from all buildings are the most satisfactory and safest. Where a good spring is not available the well should be located as far as possible from dwellings and barns.

Lead pipe was used in 49 cases. In 9 instances water flowing through such pipes contained lead in appreciable amount, rendering the water absolutely dangerous for consumption.

If a water analysis is desired, application should be made to the experiment station, when a container will be shipped to the applicant together with instructions for taking the sample. Water received in receptacles other than those furnished will not be analyzed. A fee of $3 is charged for a water analysis. The experiment station does not make bacterial examinations.

Miscellaneous Work.

In addition to the work already described, this section has conducted investigations and made other analyses as follows: —

1. It has co-operated with the officials of the Massachusetts

Corn Exposition in making analyses of corn in connection with the awarding of prizes.

2. It has co-operated with the Bowker and Coe-Mortimer Fertilizer companies in making analyses of corn in connection with the awarding of prizes.

3. It has arranged and furnished exhibits and speakers, in co-operation with the extension department, for fairs, farmers' meetings and expositions.

4. It has co-operated with the agricultural department of the college in making analyses of milk in connection with the awarding of prizes at a dairy show held during "farmers' week."

5. In connection with the experimental work of this and other departments of the experiment station, this section has made analyses of 116 samples of milk, 57 samples of feed and 377 samples of agricultural plants.

6. In addition to the work already enumerated, it has received and tested 527 samples of milk, 2,799 samples of cream for butter fat, and 204 samples of feedstuffs.

Testing Pure-bred Cows.

The testing of pure-bred cows for advanced registry is in charge of this section. Work of this character can be grouped under two divisions. The yearly tests for the Guernsey, Jersey and Ayrshire breeds are based upon two-day monthly tests under the supervision of an experiment station representative; while the Holstein-Friesian tests are usually of from seven to thirty days' duration and require the presence of the supervisor during the entire testing period. The large number of yearly tests now in progress require the employment of two men continuously and of an additional man for a portion of the time. Work of this character can be planned ahead and more readily taken care of than the Holstein-Friesian tests. For this latter work a list of available men is kept, and applications for supervisors are filled in the order received. Men who make the Holstein-Friesian tests are recruited largely from the short-course graduates who have gone back to the farm and who do not find it difficult to get away during the winter months. During the summer months considerable difficulty is experienced in getting

men for the work. Fourteen different men have been used on work of this character during the year.

From Dec. 1, 1910, to Dec. 1, 1911, 38 Guernsey, 117 Jersey and a number of Ayrshire tests have been completed. There are now on test 43 Guernseys, 99 Jerseys, and 12 Ayrshires, located at 18 different farms.

For the Holstein-Friesian Association there have been completed 103 7-day tests, 2 30-day tests and 1 14-day test.

REPORT OF THE BOTANIST.

G. E. STONE.

The routine and research work of this department during the year has followed prescribed lines, although, as occasion has demanded, new lines of research were taken up. Mr. G. H. Chapman, besides assisting in carrying on the routine work, has had considerable opportunity for the study of special problems. He has completed his investigations on mosaic and allied diseases, as well as a piece of work on the "Microscopic Identification of the Components of Cattle Feeds."

Mr. Sumner C. Brooks, who served one year in the laboratory, resigned his position in October to take up graduate work at Harvard, but unfortunately just before his year expired he was severely stricken with typhoid fever and is at present in a convalescent state. Mr. Brooks is a keen and tireless observer, and our best wishes are extended to him in his graduate work. His place has been filled by Mr. E. A. Larrabee, of the class of 1911 of this college, who has had considerable experience in our laboratory as an undergraduate student. Miss J. V. Crocker, who is thoroughly familiar with our work, has been of great service in attending to correspondence, assisting in the seed work and in other ways. Much help has also been received from Mr. R. E. Torrey and Messrs. Larsen and Ellis, all of whom are associated with the laboratory as undergraduate students.

Besides giving considerable time to such routine work as correspondence and the diagnosis of diseases, our own attention has been directed to the investigation of a dozen or more original problems. Much time has also been spent in studying and devising apparatus designed for the better control of the various foes of plant life.

Besides the correspondence relating to seed work and the control of diseases, we are constantly called upon to answer letters of a very special and technical nature. These inquiries come from everywhere and cover a multitude of subjects, such as electricity and plant growth, electrical injury to trees, illuminating and other gases, chemical treatment of reservoirs, modern tree surgery, court decisions regarding shade trees, different stimulating factors in the growing of plants, requests for advice in regard to devices for the extermination of various pests, etc.

REPORT OF THE ENTOMOLOGIST.

H. T. FERNALD.

The work of the entomological department during 1911 has been mainly on subjects previously outlined, and any report is, therefore, practically a report of progress.

The insect collection of the station has received considerable attention during the year. Numerous additions by gift from former students of the college and others, and the addition of more cases and other equipment in order to provide room for the proper care and growth of the collection as a whole, have made it possible to put it in better condition than ever before. As it is in constant use for reference and study, this improvement has been greatly appreciated.

The time at the disposal of those working in entomology is divided between four different lines of work. These are: correspondence with persons desiring the assistance of the department; care and improvement of the station collections of insects and their work; experimental work and studies under the Hatch act; and research under the Adams fund. These may be considered in the order named.

The correspondence the past year has been as large or somewhat larger than heretofore, but very different in nature from what it was formerly. For many years most of the inquiries received were about noticeably injurious insects. More recently, however, the inquiries have had reference to the less evident, though often equally serious pests. This indicates progress in the knowledge of our injurious insects among those most concerned and is certainly gratifying, being at least indirect evidence of the efficiency of this department and of the other

sources through which entomological information has been distributed in this State. From this time on, however, it will be more difficult than formerly to determine from the correspondence itself the nature of the insect concerned, and it is probable that visits to places where damage is being caused will be much more frequently necessary in order to give intelligent advice as to the proper methods of control.

The importance of a collection of insects and of their work would seem to be almost self-evident. Any entomologist taking up duties either State or station in character, who finds no collection or only a small one where he goes, labors under an immense handicap, and within a year or two a number of letters expressing this in most emphatic terms have been received by the writer from friends laboring under such conditions. This station is fortunately situated in this regard, having a good collection, containing many entire life histories, and well cared for. It is far from complete, however, and is deficient in many different stages, even of common forms. To be what it should be, it is important not only to maintain it in its present condition, but to add to it as rapidly as possible specimens of all the injurious insects which can possibly be obtained, in their different stages, together with samples showing the nature of the injuries they cause. As much work of this kind as possible has been carried on during the past year.

Under the Hatch act experimental studies of various kinds have been continued. The destruction of seed corn by wireworms has been studied as in previous years, in co-operation with Mr. Whitcomb. As stated in the last report, tests of tar and Paris green proved successful, but when tried by many different persons in various parts of the country were not always satisfactory. The trouble in most cases seems to have been that so much tar was applied as to give the corn a waterproof covering, which prevented germination. This was not the fault of the method, but was due to its improper application. A real defect of the method was that it required two treatments, first with the tar and second with the Paris green and dust. To avoid this, tests were made last spring with arsenate of lead diluted to the thickness of paint. The results were not wholly satisfactory, partly because wire-worms were not everywhere

abundant throughout the test fields, and partly because the arsenate showed a tendency to flake and drop off the corn. In most cases the corn made a good start and escaped all injury, even though wire-worms were clustered around the seeds in the row. In fact, the treatment, though it did not seem to kill the wire-worms, did appear to protect the corn from injury in nearly every case. Further experiments along this line will be made in 1912.

The testing of new spray materials has not usually been looked upon favorably by this department, as it has no trees under its control upon which these may be used. A new material called "Entomoid," for use against the San José scale, sent to the station last year for trial, seemed so promising, however, that considerable attention was given to it, trees loaned for the purpose by individuals being used. Entomoid is claimed by its inventor to be a combination of lime-sulfur and a miscible oil, and therefore to combine the good qualities of both of these materials. It was applied to young apple and plum trees considerably to badly infested with scale, shortly before the buds opened in the spring, at strengths of 1 part Entomoid to 20 of water, and to 30 of water, using a fine Vermorel nozzle. The trees were under almost continual observation thereafter, until October, and the results were very satisfactory with both strengths. Very few living scales could be found in June, and those were all in such protected positions as would indicate a probable failure of the spray to reach them. By late fall the trees were well infested again, but only to such a degree as would be easily accounted for by the few scales which escaped treatment, and by restocking from badly infested trees nearby. During the past year the inventor has modified his formula somewhat, and it is the intention to continue tests with this modified material the coming spring.

In addition to the experiments outlined above, observations on the dates of hatching of the oyster-shell scale, scurfy scale and pine-leaf scale have been continued, and it is planned to conduct tests of methods for the control of the onion maggot next season, should satisfactory opportunities become available.

While not forming a part of the work done under the Hatch act, it may be well to mention that exhibits of injurious insects

and their work, with directions for treatment to control these pests, have been prepared and exhibited at a number of fairs and exhibitions during the past year, the department co-operating with the extension department of the college whenever it has been requested to do so. Samples of pests and their work have also been put up and sent to libraries, schools and individuals in some cases where the material could be obtained and the time necessary to prepare these exhibits could be spared from more pressing duties.

Calls for the fumigation of houses to destroy various household pests have been frequent. As there is no one near Amherst who makes a business of work of this kind, and as experience in handling hydro-cyanic acid gas is necessary, if danger to human life is to be avoided, it has seemed wise to do more or less of this, partly as an educational measure. During the past year perhaps 15 or 20 places have, therefore, been fumigated by members of this department at the request of persons concerned, who were willing to meet the cost of the work.

Under the Adams fund the two projects previously accepted have been continued. Studies of the causes of the burning of foliage by arsenicals, postponed by failure to obtain materials of known composition and purity, have now been taken up, and 120 different spraying tests were made during the season, followed in each case by examination of the results, at least every second day for about a month. The results are interesting, but the work thus far represents only a small fraction of that which will be necessary before this subject has been developed to the point desired, and the results of such a fragmentary part of the work, it is, of course, not desirable to publish.

Study of the real value of wasps as parasitic friends of man have been continued, and one small paper incorporating a few of the more technical preliminary observations has been completed. Both of the Adams fund projects will be prosecuted farther the coming year.

Aside from what has thus far been mentioned, a study of the distribution of insect pests in the State has been continued. It is increasingly evident that some portions of Massachusetts are outside of territory liable to serious injury by certain insects. The determination of the limits of these areas and the reasons

for their existence are important problems awaiting solution. The possibility that in one part of the State certain southern crops can be successfully grown is supported by the continued existence in that section of plants, reptiles, birds and insects which normally occur much farther south. If this should prove to mean that some southern crops can be raised in that section, and our city markets be supplied with them after the supply from the south has ended, it might result in marked changes in the crops in that portion of the State. Evidence bearing upon this has been and is being gathered at every opportunity, in the hope that the results may justify practical tests of the idea here suggested.

REPORT OF THE VETERINARIAN.

JAS. B. PAIGE, D.V.S.

During the past year the veterinary department has carried on its work in accordance with the following scheme: —

1. Research.
2. Diagnosis.
3. Correspondence.

Since the inauguration of the department in the experiment station it has been the aim and practice to carry on each year one or more lines of original investigation of some of the obscure animal diseases or phase of the same, preferably one of immediate interest to the stock owners of the State. The large number of diseases occurring among the different farm animals, the cause, course, successful treatment or prevention of which are not fully understood, offers a large field for investigation and profitable study. Such obscure diseases exist among all varieties of farm animals, — horses, cattle, sheep, swine and poultry. The latter presents some of the most difficult and interesting problems for investigation.

For nearly two years prior to last September the head of the veterinary department, in addition to his regular work of instruction in the college, performed the duties, in part, of the dean of the college. This required a greater part of each afternoon of the days when college was in session. It was, therefore, during this time not possible to engage as extensively in the lines of original investigation as was desired. The remainder of the work in the station falling under divisions of diagnosis and correspondence were taken care of in a satisfactory manner.

For something more than two years an original investigation

has been carried on to determine to what extent unsterilized, mixed milk from herds of common dairy cattle, not tuberculin tested, may be responsible for the transmission of bovine tuberculosis. The work is nearly completed and will appear as a separate contribution to the report, or in bulletin form, at an early date.

The general plan of the experiment has been to make it of a practical nature by carrying it out under conditions as nearly like those as are found in the farmers' stables and herds, and at the same time sufficiently guarded against error to give it a scientific value in the determination of the relation of milk as an agency for the transmission of the disease under ordinary farm conditions. The investigation has its practical application in the eradication of tuberculosis from herds by the use of tuberculin as a diagnostic and by every other known means. If the disease is to be stamped out in a herd of cattle it is not alone sufficient to discover and remove those animals already affected, but also to discover and remove the source from which the infection comes. The experiences of the past of those who have tried to rid a herd of tuberculosis by the use of tuberculin and by slaughter of affected animals and disinfection of stables, have shown that it is not easily accomplished, owing to the difficulty of detecting the origin of the cases that are almost certain to appear after diseased animals have been removed and the stable thoroughly and effectively disinfected. It frequently happens that after a variable period of several weeks to as many months more indications of the existence of the disease are discovered among the animals which necessitate the repetition of the tuberculin testing and disinfection. The possible source of reinfection has in some instances been directed to milk from infected and nontuberculin-tested animals not showing marked physical symptoms of tuberculosis, but excreting tubercle bacilli in their milk.

In the case of large dairy herds or those of large public institutions, where sufficient milk is not produced by the herd at all seasons to supply a trade or for home consumption, it frequently happens that milk from untested cattle is purchased and brought onto the farm, and possibly some remaining unsold or unused is fed to calves or hogs and proves the source of the

infection, which accounts for the recurrence of the disease. To determine to what extent this may be the source of such recurrence of tuberculosis of farm animals is the chief aim of the present investigations.

In addition to the experiment with milk, to determine to what extent it may be the medium for the transmission of bovine tuberculosis, there have been started preliminary studies to determine the nature, cause, means of spread, treatment and prevention of several other animal diseases, including an extremely obscure and fatal one of fowls. The work has not progressed sufficiently, at this date, to warrant more than a mention of the fact in this report.

The diagnosis work consists of the examination of material that is sent in by stockmen from animals suffering with disease, and of material suspected of causing disease. During the past year specimens have been received in larger numbers than ever before, and from practically every part of the State. As soon as such specimens arrive they are subjected to a variety of examinations, microscopic and bacteriological, to determine the nature of the material and the possible relation to the disease causing a loss to the stockman. After the completion of the examination, a report upon the nature of the specimen and directions for the treatment or prevention of the disease is sent to the farmer from whom the material was received. While not possible to arrive at a correct diagnosis in every instance, in many cases it is possible to return to the sender of the specimen such definite information as to the nature of the material and the disorder as to enable him, by following the directions sent in the report, to eradicate, cure or prevent the disease.

Some of the most interesting and important specimens that have come under observation in the diagnosis work the past year are: tuberculosis of garbage-fed hogs; tubercular orchitis of bull; pulmonary phthisis of man; pericarditis of cattle due to foreign bodies; lobar pneumonia; papilloma and fibroma of bovines; Paris green poisoning of pigs; chicken pox; coccidiosis and favus of birds.

In addition, a large number of samples of fodder, grain, beef scrap and other food materials have been examined as to quality and the presence of substances liable to cause disease when fed

to animals. One particularly interesting sample of poor quality corn stover and corn on the ear was received that had caused the death of several cattle in a herd owing to the presence of large amounts of alcohol and other products of fermentation and decomposition that it contained.

Several samples of milk sent in for examination have been found to be contaminated with bacteria, giving rise to disagreeable odors, bitter tastes and offensive discolorations.

While the diagnosis work requires a great amount of time it certainly is fruitful of the best results. Notwithstanding the fact that it is not possible from the nature of the specimen sent, or the condition in which it may be received, to make a correct diagnosis in every instance, in the majority of cases it is possible to return to the farmer information of value that may enable him to avoid or arrest diseases that cause considerable loss. It is a means of bringing the veterinary service of the experiment station to the aid of those farmers who are so situated that they cannot avail themselves of the services of the private veterinary practitioner.

The correspondence branch of the service is closely co-ordinated with the diagnosis work. It frequently happens that farmers write to the department for information relative to some disease that exists among their animals. From the details of symptoms given in such cases it is often possible to arrive at a correct diagnosis of the trouble and advise the writer what course to follow to stamp out, successfully treat or prevent the disease. In other instances no satisfactory conclusions can be reached from the communication received and a specimen is asked for, by which a correct diagnosis of the trouble can be made and satisfactory directions given, by mail, for the successful treatment of the case. Specimens from diseased animals obtained in this manner not only furnish a means for making a correct diagnosis, and enable us to give intelligent advice to the owner of the animals, but they also supply materials of the best quality for classroom and laboratory demonstrations for students taking the courses in veterinary science and bacteriology in the department.

The correspondence of the past year has called for information covering a wide range of subjects relative to the care and

feeding of farm animals and numerous animal diseases, among which may be mentioned: milk fever of cows; contagious and sporadic abortion; hog cholera; intestinal parasites of horses, cattle, sheep and swine; tuberculin testing, etc.

An especially large number of letters have been received asking for information concerning the source, symptoms and treatment of hog cholera. From the increase of inquiries over previous years and the press reports, it appears that this disease has been much more prevalent in the State during the past twelve months than ever before.

If the stockmen could only realize that the great majority of the outbreaks of hog cholera have their origin in swill containing scraps of uncooked western pork from centers of infection, and that thorough cooking will destroy the infection, many of the troublesome outbreaks could be easily prevented, and the swill from hotels and boarding houses into which such contaminated pork scraps are almost certain to find their way could be fed with safety and profit in the rearing and growing of hogs in Massachusetts.

HEREDITY, CORRELATION AND VARIATION IN GARDEN PEAS.

J. K. SHAW.

During the past five years a portion of the time devoted to experimental work in the department of horticulture has been directed toward the solution of problems of plant breeding, the work being done mostly with garden peas. Certain phases of this work have been previously reported.[1] It is felt that sufficient progress has now been made to warrant a more complete and definite statement of results attained.

The original purpose of the work was a study of variation, and the subsequent development along lines of correlation and inheritance has been a gradual one, with no endeavor to prove or disprove any of the current theories bearing on these questions, but with an earnest purpose to secure facts. After five seasons' work it was felt that sufficient data had been accumulated to afford a basis for a few deductions, and following last season's crop, results have been worked over and are here presented. This explanation may make clear the seeming lack of definiteness and direction of the work towards the results obtained.

The work began in 1907 with a study of variation in a commercial lot of Excelsior peas, and in 1908 a lot of First of All was added; since then various commercial sorts have received more or less attention. The most important results have been reached by means of the Excelsior variety. This is a second early wrinkled pea growing usually about 40 centimeters in length and bearing about four pods to the vine. It is a sort considerably grown by gardeners in New England.

The principal characters dealt with have been vine length and pods per vine. The first gives a good measure of the vegetative

[1] Reports, Massachusetts Experiment Station, 20, p. 171; 21, p. 167; 22 Part I., p. 168.

vigor of the plant and the second of its productiveness, — two qualities of the greatest economic importance.

All the measuring for the past three years, when most of the plants have been handled, has been done by one individual, thus avoiding the slight differences that might result from the work of different men.

The vines have been carefully pulled when well ripened and carried to a convenient table where the measurements have been made. Vine length has been taken from the surface of the ground to the uppermost node of the main stem. Where there were branches they have been measured, but are not used in the computations, though it might have been more desirable to have done so. However, it is not felt that in that case the results would have been materially different. All pods have been counted whether large enough for commercial purposes or not, as have the peas in the pod. The measurements have been recorded on 5 by 8 cards, recording the data as shown in Fig. 1.

Plant.	Vine Length.	No. Pods.	Peas per Pod.	Total Peas.	Notes.
B-10-7-1	62	5	7-7-5-6-6	31	
2	85	6	5-6-3-6-7-4	31	
3	64	6	1-4-6-0-5-6	22	
4	70	6	4-6-5-6-5-5	31	
5	70	5	6-1-5-5-0	17	
6	53	5	4-2-0-4-4	14	
7	54	4	2-5-5-2	14	Seed
8	63	6	5-6-6-4-3-2	26	
9	50	3	3-6-2	11	
10	44	4	4-4-5-1	14	
11	52	5	4-5-6-5-3	23	
12	70	5	5-5-6-5-5	26	
13	64	6	0-6-6-6-6-4	28	
14	55	4	5-3-3-3	14	
15	63	6	5-5-5-7-5-2	29	
16	35	4	4-4-3-3	14	
17	45/36	8	4-3-5-2/3-4-3-3	27	
18	63	6	4-6-6-6-5-6	33	

Fig. 1. — Pea Record Card.

The plants have been grown each year upon a different plot of ground and these have not always been as satisfactory, especially as to uniformity, as might be desired. In 1908 the plot, while fairly uniform, was gravelly, and suffered somewhat from drought, which modified the character of the plants grown to a considerable degree. In 1909 the soil was heavier, but one end of the plot was inferior as shown by the appearance of the plants grown. In 1910 the soil of the plot seemed fairly uniform, but the error was made of applying fertilizer in the row. While an effort was made to have this uniform all through the plot, it appeared that it was not fully successful, some portions of the rows receiving more stimulus than others. The plots used in 1911 appeared to be more desirable than those used previously, and were so on the whole, yet they were not all that could be desired, some portions being evidently poorer than the average, as indicated by the slightly less flourishing plants. Perfect uniformity of soil, however desirable in work of this kind, is very difficult and perhaps impossible to attain, and this must be compensated for by duplication of results. It is felt that in this work sufficient duplication has been carried out to neutralize this variation in soil conditions, and that the conclusions reached are not materially affected thereby.

The mathematical calculations have been carried out with the aid of millionaire and comptometer calculating machines and fully checked, and it is felt that they are free from errors that could sensibly affect the results. The methods that have been used are for the most part the usual ones and substantially as set forth in "Principles of Breeding," by E. Davenport.

Heredity.

In what degree may individual pea plants be expected to transmit their characters to their descendants? Table I. sums up the measure of inheritance of vine length and productiveness of about 10,000 plants in an effort to throw light on this question. Before discussing this table it is necessary to set forth the history and nature of the four groups dealt with.

TABLE I. — *Coefficients of Heredity.*

Vine Length.

Plant.	1908-09.	1909-10.	1910-11.	Average.
First of All,	-	+.0486 +.0242	+.0407 +.0257	+.0447
Excelsior I.,	+.2159 ±.0167	+.0236 ±.0170	+.0583 ±.0196	+.0993
Excelsior II.,	-	+.3095 ±.0172	+.0892 ±.0236	+.1994
Variety "C,"	—.0801 ±.0392	+.0372 ±.0241	—.0161 ±.0409	—.0197
Pods per Vine.				
First of All,	-	+.0435 +.0242	—.0564 +.0256	—.0065
Excelsior I.,	+.0782 ±.0174	—.0159 ±.0170	+.0140 ±.0197	+.0254
Excelsior II.,	-	+.0145 ±.0189	+.2317 ±.0225	+.1231
Variety "C,"	—.0433 ±.0395	—.0914 ±.0239	+.0046 ±.0399	—.0434

The plants grouped as First of All are from a lot of commercial seed of the variety bought in the open market. They were first grown in 1907, but the seed from individual plants was not saved separately until the fall of 1909, so that no coefficients of heredity are available except for the crops of 1910 and 1911. The number of plants of this group grown each year is in the vicinity of 700. The method of choosing seed plants is as follows: In the fall of 1908 seed from every tenth plant was saved, a special effort being made to make the tenth plant a random choice. In the following year the seed of one plant, chosen at random from the descendants of each of these tenth plants, has been saved for planting. In this way the number of plants has been kept fairly constant.

The same remarks will apply to the group Excelsior II., except that the number of plants has been greater, varying from 800 to 1,200 each year.

The groups called Excelsior I. and Variety "C" are both from the same lot of commercial seed, originally as Excelsior II., but these are descended from 10 plants selected in the fall of 1907, the seed of each being saved separately. In the spring of 1908 the seed of each of these plants was sown separately and 227 plants grown therefrom. The seed of each of these was separately saved and grown in 1909, resulting in 1,770 plants.

In the fall of 1909 and subsequent years a random selection of one plant from each of the groups of 1909 has been made, thus keeping the number of plants fairly constant. It will be seen that Excelsior I. and Variety " C " are made up of the descendants of 10 plants selected from commercial seed. The reason for separating one of the 10, " C ", is that it has proved to be a distinct variety, being larger, more productive and a week or ten days later than the other 9. This difference was not suspected when the original plant was selected. Between these 9 lines of descent there are no evident differences, though some are shown later in this paper to be present.

With these explanations in mind we may proceed to a discussion of the figures shown in Table I. The following conclusions seem warranted: —

1. With three exceptions the coefficients are very small, many are insignificant and some are even negative.

2. They are very irregular both in the same groups in different years and in different groups in the same year.

3. They are generally lower for pods per vine than for vine length.

4. They are on the whole lower for Variety " C " than for the other groups.

It will be remembered that Variety " C " comprises the descendants from 1 of 10 plants selected from a lot of Excelsior in 1907, the progeny of the other 9 being brought together to form the group Excelsior I. We have the figures for these 9 lines taken separately, and we may inquire if they, like Variety " C ", are insignificant or nearly so. They are given in Table II.

TABLE II. — *Coefficients of Heredity of Single Lines.*

Vine Length.

PLANT.	1908-09.	1909-10	1910-11.	Average.
A,	+.1701 ±.0482	—.0632 ±.0454	—.1737 ±.0516	—.0223
B,	+.2202 ±.0515	+.2841 ±.0460	+.0075 ±.0545	+.1706
D,	—.0556 ±.0471	—.0016 ±.0459	+.1242 ±.0477	+.0223
E,	+.0823 ±.0865	—.2122 ±.0587	—.0610 ±.0611	—.0636
F,	+.1472 ±.0812	+.1820 ±.0810	+.1651 ±.1110	+.1648
G,	—.1380 ±.0390	—.1652 ±.0351	—.0391 ±.0490	—.1141
H,	—.0549 ±.0462	+.1232 ±.0450	+.1353 ±.0498	+.0679
J,	+.1563 ±.0591	+.2165 ±.0663	+.2535 ±.0859	+.0679
K,	+.0298 ±.0554	+.2348 ±.0570	+.0689 ±.0720	+.1112
Average,	+.0619	+.0663	+.0534	+.0450 +.0605

Pods per Vine.

PLANT.	1908-09.	1909-10	1910-11.	Average.
A,	+.1372 ±.0488	—.1948 ±.0438	—.2106 ±.0508	—.0894
B,	+.2392 ±.0511	+.1748 ±.0485	—.1423 ±.0534	+.0906
D,	—.0521 ±.0471	+.0872 ±.0456	—.0477 ±.0483	—.0042
E,	+.0626 ±.0867	—.2371 ±.0642	—.0147 ±.0613	—.0631
F,	—.3311 ±.0775	+.0986 ±.0835	+.1414 ±.1102	—.0304
G,	+.0277 ±.0390	—.2317 ±.0341	—.0453 ±.0490	—.0498
H,	+.0681 ±.0436	—.0658 ±.0456	+.1165 ±.0500	+.0396
J,	+.1398 ±.0594	—.0469 ±.0696	—.1180 ±.0905	—.0084
K,	+.1337 ±.0545	+.2293 ±.0572	+.0463 ±.0718	+.1364
Average,	+.0472	—.0207	—.0305	+.0024 —.0013

A study of this table shows it to be in harmony with the first three conclusions drawn from Table I. It indicates further that the true coefficient of heredity within these single lines of Excelsior peas is about +.06 for vine length and practically zero for pods per vine.

There is generally a positive correlation between seed weight and the size of the plant produced. The question which now arises is whether this is sufficient to account for the small plus correlation in vine length shown in Table II. We have a few figures bearing on this point, but not enough to determine positively whether this is the case or not. The seed weights avail-

able were taken from another selection of plants from Excelsior I., not already dealt with, and from a commercial lot of Alaska. The latter is a variety with small, round, green seeds and with somewhat longer vines than Excelsior. These selections were of the long and short vines, and the more productive and less productive vines. This explains the small number of medium-length vines in Tables III. and IV. A few points brought out in Table III. should be noted: —

TABLE III. — *Correlation of Vine Length and Average Weight of Seeds borne, Excelsior I.*

Average Seed Weight (Grams).	Vine Length (Centimeters).													
	13	18	23	28	33	38	43	48	53	58	63	68	7	Total.
.10, . .	1	–	–	–	–	–	–	–	–	–	–	–	–	1
.15, . .	–	2	–	–	–	–	–	–	–	–	–	–	–	2
.16, . .	–	–	–	2	–	–	–	–	–	–	–	–	–	2
.17, . .	–	1	2	1	–	–	–	–	–	–	–	–	–	4
.18, . .	–	–	–	1	–	–	–	–	–	–	–	–	–	1
.19, . .	–	–	–	–	–	–	–	–	–	–	–	–	–	–
.20, . .	4	6	4	2	2	–	–	–	–	–	–	–	–	18
.21, . .	–	–	–	–	–	–	–	–	–	–	–	–	–	–
.22, . .	–	–	3	5	–	1	–	–	–	–	–	–	–	9
.23, . .	–	4	1	3	1	1	–	–	2	–	1	–	–	13
.24, . .	–	–	3	–	1	–	1	1	1	2	–	–	–	9
.25, . .	1	1	4	2	1	–	–	2	2	–	–	–	–	13
.26, . .	–	1	1	3	1	–	2	4	7	–	–	2	–	21
.27, . .	–	4	2	3	–	1	2	–	5	5	1	–	–	23
.28, . .	–	–	1	–	1	–	–	1	4	1	1	1	–	10
.29, . .	–	–	–	–	–	1	1	1	3	–	–	–	–	6
.30, . .	–	3	3	1	5	1	–	1	2	–	1	–	–	17
.31, . .	–	–	–	–	–	–	–	–	–	1	–	–	–	1
.32, . .	–	–	–	–	–	–	–	–	1	–	–	–	–	1
.33, . .	–	–	–	1	–	–	–	–	–	1	–	–	–	2
.34, . .	–	–	–	–	–	–	–	–	1	–	–	–	–	1
.44, . .	–	–	–	–	–	–	–	–	–	1	–	–	–	1
Total, .	6	22	21	24	12	5	6	10	28	11	4	3	–	–

TABLE IV. — *Correlation of Vine Length and Average Weight of Seeds borne, Alaska.*

AVERAGE SEED WEIGHT (GRAMS).	VINE LENGTH (CENTIMETERS).																			
	18	**23**	**28**	**33**	**38**	**43**	**48**	**53**	**58**	**63**	**68**	**73**	**78**	**83**	**88**	**93**	**98**	**103**	**108**	Total.
.08, ...	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1
.09, ...	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
.10, ...	1	2	5	2	–	1	2	1	–	–	–	–	–	–	–	–	–	–	–	14
.11, ...	–	–	–	1	–	–	1	–	–	–	–	–	1	–	–	1	–	–	–	4
.12, ...	–	–	2	2	4	3	5	2	1	–	1	1	1	1	–	–	–	–	–	23
.13, ...	–	1	–	4	4	2	3	–	–	2	–	1	1	–	1	1	–	–	–	20
.14, ...	–	–	–	–	3	5	5	3	1	–	1	2	3	3	1	–	–	–	–	27
15, ...	–	1	1	3	2	5	6	5	2	1	1	–	2	4	5	2	–	–	–	40
.16, ...	–	–	–	–	–	5	7	4	–	1	1	3	4	4	3	2	2	–	–	36
.17, ...	–	2	–	1	2	6	3	1	–	–	–	1	6	2	3	3	1	2	–	33
.18, ...	–	–	–	–	1	2	2	1	2	–	2	–	1	3	1	1	–	–	–	16
.19, ...	–	–	–	–	–	–	–	–	–	1	1	–	2	2	1	2	1	–	–	10
.20, ...	–	2	–	–	–	–	1	–	–	–	–	1	–	1	–	1	–	–	–	6
.21, ...	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	2
.22, ...	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1
Total, . .	1	8	8	14	16	30	35	17	7	5	7	9	21	22	15	13	4	2	–	–

1. No vine over 35 centimeters long produced seeds averaging less than .22 grams each.

2. Vines 35 centimeters or less produced many light seeds and also many fairly heavy seeds, but none as heavy as the long vines produced; the average weight is far more variable.

The same is true of the Alaska peas as shown in Table IV., though less strikingly so owing to the smaller variability of average seed weight in this variety.

TABLE V. — *Correlation of Vine Length and Average Weight of Seeds.*

Excelsior I., 40 centimeters or less, ...	$+ .3038 \pm .0635$
Excelsior I., 41 centimeters or more, ...	$+ .1669 \pm .0833$
Alaska, 60 centimeters or less, ...	$+ .2779 \pm .0534$
Alaska, 61 centimeters or more, ...	$+ .1662 \pm .0663$

In order to compute fairly the coefficient of correlation in these two groups it is necessary to compute for the short and long vines separately. The coefficients are given in Table V.

This table shows, in the case of both varieties, fairly large coefficients, and they are in both cases larger for the short vines than for the long vines. These figures form a too slender basis for a definite conclusion as to the correlation between vine length and the average weight of peas produced, but so far as they go they consistently favor the supposition that the correlation does exist and is fairly large. The average of the four is +.2287.

TABLE VI. — *Correlation of Average Seed Weight and Vines produced.*

Strain A, D, F, G, K,	+ .0710 ± .0234
Strain B, E, H, J,	+ .1045 ± .0286
Alaska,	+ .0146 ± .0178
First of All,	— .0290 ± .0390

Turning now to the consideration of the question as to whether the heavier peas produce larger vines than do the lighter ones, we have the figures shown in Table VI. For reasons shown a little further on in this paper, the group Excelsior I. is divided into two strains, one of 5 lines and the other of 4 lines as shown in the table. The group First of All is from a selection of this variety that is of the same nature as the others. The number of vines is relatively small, and the figures, therefore, of less value than the other groups. It is because of the small numbers that the correlation of parent vine length and weight of their seeds are not given, but as far as they go they are in reasonable agreement with those of the two groups that are given.

It appears from the limited data given in Table VI. that the correlation is larger for the wrinkled Excelsior peas than for the starchy Alaska and First of All varieties. Only the coefficients for the first two groups should therefore be compared with the correlation of about +.06 found to exist between parent and offspring as shown in Table II.

No positive conclusion in this matter can be drawn. The indications are that a part and possibly all of the correlation of .06 may be accounted for by the correlation between length of vine and seed weight.

TABLE VII. — *Averages of the Single Lines.*

Original Plant.	Vine Length (Centimeters).	Mean Vine Length. 1908.	1909.	1910.	1911.	Average.
A, . . .	70	39.53 ±0.74	42 19 ±0.47	51.86 ±0.44	42.88 ±0.57	44.12
B, . . .	53	30.19 ±0.76	36.16 ±0.50	45.61 ±0.46	35 75 ±0.52	36.93
C, . . .	64	47.10 ±0.67	59.75 ±0.41	70.95 ±0 25	54.81 ±0.47	58.15
D, . . .	57	37.78 ±0.78	47.56 ±0.54	43.46 ±0.48	42.43 ±0.51	42.81
E, . . .	68	33 06 ±1.14	36.75 ±0.89	43.70 ±0 54	37.42 ±0.60	37.73
F, . . .	63	41.43 ±1.48	48.83 ±1.02	37.62 ±0.66	41.71 ±1.07	42.40
G, . . .	69	42.50 ±0.77	46.36 ±0.39	42.66 ±0.49	43.61 ±0.49	43.78
H, . .	61	34.35.±0.61	41.15.±0.41	36 44 ±0.36	38.76 ±0.46	37.68
J, . . .	65	36.72 ±0.55	38.77 ±0.53	33.80 ±0.60	35.69 ±0.84	36.25
K, . . .	55	44.88 ±0.67	46.55 ±0.51	38.24 ±0.54	35.90 ±0.75	41.39

Original Plant.	Pods per Vine.	Mean Vine Length. 1908.	1909.	1910.	1911.	Average.
A, . . .	11	3.00 ± 13	5.23 ±.11	4.78 ±.08	5.85 ±.15	4.72
B, . . .	17	2 91 ±.03	5.00 ±.13	4.70 ±.09	5.13 ±.13	4.44
C, . . .	9	5.32 ±.31	12.45 ±.27	7.77 ±.08	8.62 ±.17	8.54
D, . . .	7	3.26 ±.04	6.79 ±.14	3.88 ±.08	5.34 ±.11	4 82
E, . . .	4	2.81 ±.05	5 52 ±.22	4 18 ±.11	5.36 ±.13	4 17
F, . . .	3	3.57 ±.19	6.10 ±.26	3.16 ±.09	4.80 ±.20	4.41
G, . . .	9	4.70 ±.09	5.06 ±.09	3.59 ±.05	5.61 ±.12	4.97
H, . . .	11	3.15 ±.03	4.78 ± 09	3.02 ±.05	4.64 ±.11	3.90
J, . . .	4	3.05 ±.03	4.92 ±.12	3.16 ±.11	4.56 ±.21	3.92
K, . . .	4	3.75 ±.05	6 11 ±.20	3.62 ±.09	4.30 ±.12	4 45

A study of the averages of vine length and pods per vine of the 9 lines of descent, comprehended in the group Excelsior I., is of interest. These are shown in Table VII. and the remaining line, otherwise known as Variety " C ", is included for purposes of comparison. The most striking thing brought out in the table is the fact that averaging the mean vine length for the four years under observation, we find that 5 of the lines A, D, F, G and K are grouped very closely around 43 centimeters while 4 others, B, E, H and J, are grouped closely around 37 centi-

meters.[1] The remaining line C being, as already stated, obviously a distinct variety, has a vine length much greater than any of the others.

The two groups above designated may be spoken of as strains. their component parts being known as lines, each of which is, as before explained, composed of the descendants of a single plant. The means of the several lines vary greatly from year to year, due to the varying conditions of weather and of the soil of the different plots on which the crops were grown. The relations of the mean lengths of the several lines in the same years also vary greatly. Much of this is obviously due to varying soil conditions. They are more consistent with the four-year averages, in 1911, than in the previous years, the only very marked departure being the case of line K, which is much below the average. They are extremely variable in 1910, when, as already stated, the unwise method of applying fertilizer in the row was followed.

Whether the slight departure of the averages of the different lines of either strain have any significance in inheritance is questionable. Only further testing under more uniform conditions would determine this.

Great differences are shown in the mean number of pods per vine. They follow the mean vine lengths only in a general way, and do not show very clearly the segregation into two strains as do the mean vine lengths. This might be expected in consideration of the slight coefficient of heredity of pods per vine already shown. Nevertheless, the average number of pods in the long-vined strain is about 15 per cent. greater than in the other, while the vine length is only about 16 per cent. greater. We have here a result of the greater variability of pods per vine over vine length that will be more fully discussed later in this paper.

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[1] This explains the division of Excelsior I. in Table VI.

TABLE VIII. — *Coefficients of Heredity within Strains.*

Vine Length.

	1908-09.	1909 10.	1910-11.	Average.
A, D, F, G, K, ...	+.0081 ± .0225	—.0646 ± .0215	+.0682 ± .0269	+.0039
B, E, H, J, ...	+.1733 ± .0270	+.0355 ± .0276	+.0200 ± .0300	+.0763
Average, ...	+.0907	—.0146	+.0441 +.0401	+.0401

Pods per Vine.

	1908-09.	1909 10.	1910-11.	Average.
A, D, F, G, K, ...	—.0169 ± .0220	—.0072 ± .0216	+.0059 ± .0261	—.0061
B, E, H, J, ...	+.0343 ± .0280	—.0722 ± .0276	+.0292 ± .0299	—.0032
Average, ...	+.0087	—.0397	+.0176 —.0045	—.0047

If these strains are homogeneous, and if the positive correlation shown in the first three groups in Table I. is due chiefly to the mixture of distinct strains or lines having different means, as appears to be the case, we should get when we compute for each of the strains as a unit, coefficients similar to those given in Table II. They are given in Table VIII. It is seen that they are similar on the average, having a little lower positive correlation for vine length and an insignificant negative correlation for pods per vine.

CORRELATION.

The data on vine length and pods per vine already presented give some evidence of a positive correlation between these two characters which is in accordance with common observation. In Table IX. are given some figures that show the value of this

TABLE IX. — *Correlation Coefficients, Vine Length and Pods per Vine.*

PLANT.	Year.	Coefficient of Correlation.	Mean Vine Length.
Variety "C", ...	1910	.4070 ± .0101	71.0
Variety "C", ...	1911	.3104 ± .0359	54.6
Strain A, D, F, G, K, ...	1910	.6544 ± .0124	43.9
Strain A, D, F, G, K, ...	1911	.5653 ± .0178	41.8
Strain B, E, H, J, ...	1910	.7189 ± .0133	39.9
Strain B, E, H, J, ...	1911	.6016 ± .0191	37.2
Telephone, ...	1911	.4297 ± .0277	98.9
Champion of England, ...	1911	.4766 ± .0371	98.5
Gradus, ...	1911	.5152 ± .0264	52.3
Evolution, ...	1911	.5293 ± .0266	72.2
Alaska, ...	1911	.6103 ± .0231	56.3
Thomas Laxton, ...	1911	.6180 ± .0236	53.7
American Wonder, ...	1911	.6950 ± .0174	23.0

correlation. The nature of the groups in the first part of the table has already been explained. The remaining varieties have been grown from commercial seeds bought in the open market. The table shows that the correlation coefficient is closely related to the mean vine length in different varieties. The rule that is generally, though not invariably, followed is that the longer the vine the lower the correlation between vine length and pods per vine. This is reversed in the case of the different years shown in the first part of the table. This is due to the fact that the vines branched more freely in 1911, owing presumably to weather conditions. Vine length is taken as the length of the main stem, and when there are one or more branches bearing pods it is obvious that the correlation is lessened.

To this same factor is due in part, but not wholly, the smaller correlation in the groups having longer vines.

One or two pods may be borne at each node of the plant, but at many nodes no pod is produced. Whether or not a pod is produced depends presumably on environmental conditions at the time when the early development of the node has reached a certain stage. The period of growth and node production is much longer with long-vined plants, and the plant is subjected to a greater variation of conditions. As successive nodes develop some will experience favorable and some unfavorable conditions, and this will not be in very close correlation with vine growth. In some varieties and in some seasons the production of doubled podded peduncles is more common, and this operates to disturb the correlation. This question will be further dealt with in connection with the later discussion of variation in productiveness.

Variation.

We may now proceed to a discussion of the amount and nature of the variation that has been in evidence in the different groups from season to season.

In Table X. are given the standard deviations and coefficients of variability that are available, and the means are inserted for convenience of immediate comparison, though most of them have already been given in another connection.

TABLE X. — *Variation in Vine Length and Productiveness.*

Plant.	Year.	Vine Length.			Pods per Vine.		
		Mean.	Standard Deviation.	Coefficient of Variability.	Mean.	Standard Deviation.	Coefficient of Variability.
A,	1908	39.53 ±0.74	4.80 ±0.53	12.15 ±1.34	3.00 ±0.13	.86 ±0.09	28.67 ±3.49
	1909	42.19 ±0.47	9.45 ±0.33	22.40 ±0.83	5.23 ±0.11	2.12 ±0.07	40.54 ±1.64
	1910	51.86 ±0.44	9.68 ±0.31	18.67 ±0.62	4.78 ±0.08	1.79 ±0.06	37.45 ±1.36
	1911	42.88 ±0.57	10.70 ±0.40	24.96 ±1.00	5.85 ±0.15	2.78 ±0.10	47.52 ±2.15
D,	1908	37.78 ±0.78	6.01 ±0.54	15.91 ±1.50	3.26 ±0.04	.29 ±0.03	8.90 ±0.74
	1909	47.56 ±0.54	11.40 ±0.38	23.97 ±0.85	6.79 ±0.14	3.06 ±0.10	45.07 ±1.78
	1910	43.46 ±0.48	10.46 ±0.34	24.07 ±0.82	3.88 ±0.80	1.68 ±0.06	43.30 ±1.65
	1911	42.43 ±0.51	10.47 ±0.36	24.68 ±0.89	5.34 ±0.11	2.36 ±0.08	44.24 ±1.79
F,	1908	41.43 ±1.48	5.80 ±0.00	14.00 ±2.57	3.57 ±0.19	-	-
	1909	48.83 ±1.02	12.33 ±0.72	25.24 ±1.57	6.10 ±0.26	3.03 ±0.19	49.59 ±3.72
	1910	37.62 ±0.66	7.91 ±0.47	21.03 ±1.30	3.16 ±0.09	1.11 ±0.07	35.13 ±2.34
	1911	41.71 ±1.07	9.36 ±0.75	22.44 ±1.89	4.80 ±0.20	1.75 ±0.14	36.46 ±3.30
G,	1908	42.50 ±0.77	6.29 ±0.55	14.80 ±1.23	4.70 ±0.09	.71 ±0.02	15.11 ±1.31
	1909	46.36 ±0.39	9.93 ±0.27	21.42 ±0.62	5.96 ±0.09	2.27 ±0.63	38.09 ±1.19
	1910	42.66 ±0.49	9.47 ±0.24	22.20 ±0.59	3.59 ±0.05	1.41 ±0.04	39.28 ±1.14
	1911	43.61 ±0.49	9.91 ±0.34	22.72 ±0.83	5.61 ±0.12	2.54 ±0.09	45.28 ±1.86
K,	1908	44.88 ±0.67	3.95 ±0.48	8.80 ±1.06	3.75 ±0.50	.28 ±0.03	7.47 ±0.89
	1909	46.55 ±0.51	9.24 ±0.36	19.85 ±0.81	6.11 ±0.20	3.55 ±1.39	57.63 ±1.87
	1910	38.24 ±0.54	8.96 ±0.38	23.43 ±1.05	3.62 ±0.09	1.54 ±0.07	42.54 ±2.12
	1911	35.90 ±0.75	10.47 ±0.53	29.16 ±1.60	4.30 ±0.12	1.73 ±0.09	40.28 ±2.35
A, D, F, G, K,	1908	40.70 ±0.42	6.30 ±0.30	15.48 ±0.76	3.75 ±0.08	1.19 ±0.06	31.64 ±1.65
	1909	45.97 ±0.22	10.00 ±0.16	21.67 ±0.36	6.05 ±0.06	2.80 ±0.05	46.28 ±0.88
	1910	43.92 ±0.23	10.56 ±0.16	24.04 ±0.39	3.90 ±0.03	1.60 ±0.02	41.03 ±0.72
	1911	41.86 ±0.28	10.61 ±0.20	25.35 ±0.50	5.37 ±0.06	2.47 ±0.05	45.90 ±1.01

TABLE X. — *Variation in Vine Length and Productiveness* — Con.

Plant.	Year.	Vine Length.			Pods per Vine.		
		Mean.	Standard Deviation.	Coefficient of Variability.	Mean.	Standard Deviation.	Coefficient of Variability.
B,	1908	30.19 ±0.76	5.37 ±0.54	17.79 ±1.81	2.91 ±0.03	.21 ±0.02	7.22 ±0.72
	1909	36.16 ±0.50	9.18 ±0.35	25.38 ±1.04	5.00 ±0.13	2.31 ±0.09	39.65 ±1.74
	1910	45.61 ±0.46	9.16 ±0.32	20.09 ±0.73	4.70 ±0.09	1.82 ±0.06	38.72 ±1.56
	1911	35.75 ±0.52	9.55 ±0.37	26.72 ±1.10	5.13 ±0.13	2.40 ±0.09	46.78 ±2.16
E,	1908	33.06 ±1.14	6.74 ±0.80	20.39 ±2.52	2.81 ±0.05	.28 ±0.03	9.96 ±1.19
	1909	36.75 ±0.89	10.23 ±0.63	27.84 ±1.84	5.52 ±0.22	2.58 ±0.16	46.74 ±3.44
	1910	43.70 ±0.54	8.17 ±0.38	19.00 ±0.92	4.18 ±0.11	1.65 ±0.08	39.35 ±2.10
	1911	37.42 ±0.60	9.80 ±0.42	26.18 ±1.21	5.36 ±0.13	2.15 ±0.09	40.15 ±2.00
H,	1908	34.35 ±0.61	5.29 ±0.42	15.40 ±1.29	3.15 ±0.03	.26 ±0.02	8.25 ±0.68
	1909	41.15 ±0.41	9.35 ±0.29	22.72 ±0.73	4.78 ±0.09	2.14 ±0.66	44.86 ±1.63
	1910	36.44 ±0.36	7.99 ±0.26	21.93 ±0.74	3.02 ±0.05	1.13 ±0.37	37.42 ±1.37
	1911	38.76 ±0.46	9.12 ±0.33	23.53 ±0.89	4.64 ±0.11	2.08 ±0.08	44.83 ±1.90
J,	1908	36.72 ±0.55	3.72 ±0.37	10.13 ±1.06	8.05 ±0.03	.19 ±0.02	6.23 ±0.65
	1909	38.77 ±0.53	8.82 ±0.38	22.75 ±1.02	4.92 ±0.12	2.04 ±0.87	41.46 ±2.05
	1910	33.80 ±0.60	8.61 ±0.42	25.47 ±1.33	3.16 ±0.11	1.53 ±0.08	48.26 ±2.87
	1911	35.69 ±0.84	9.16 ±0.59	25.67 ±1.77	4.56 ±0.21	2.28 ±0.15	50.05 ±3.97
B, E, H, J,	1908	34.47 ±0.40	5.80 ±0.28	16.82 ±0.84	3.03 ±0.05	.76 ±0.04	25.08 ±1.30
	1909	38.86 ±0.27	9.49 ±0.19	24.42 ±0.51	4.94 ±0.06	2.23 ±0.04	45.04 ±1.06
	1910	39.94 ±0.27	9.69 ±0.19	24.26 ±0.50	3.76 ±0.05	1.69 ±0.03	45.01 ±1.04
	1911	37.19 ±0.28	9.47 ±0.20	25.45 ±0.57	4.93 ±0.07	2.24 ±0.05	45.44 ±1.15
C,	1908	46.12 ±0.67	8.55 ±0.48	18.53 ±1.58	5.32 ±0.31	2.60 ±0.22	48.87 ±4.81
	1909	59.75 ±0.41	10.38 ±0.29	17.38 ±0.51	12.45 ±0.27	6.71 ±0.19	53.90 ±1.86
	1910	70.95 ±0.25	10.34 ±0.18	14.56 ±0.25	7.77 ±0.08	3.22 ±0.06	41.44 ±0.82
	1911	54.81 ±0.47	11.95 ±0.36	21.80 ±0.64	8.62 ±0.17	4.33 ±0.12	50.24 ±1.73
Excelsior I.,	1908	37.67 ±0.33	6.81 ±0.23	18.09 ±0.64	3.40 ±0.05	1.06 ±0.04	31.29 ±1.17
	1909	43.20 ±0.19	10.68 ±0.13	24.72 ±0.32	5.63 ±0.05	2.66 ±0.03	47.25 ±0.70
	1910	42.41 ±0.18	10.39 ±0.13	24.50 ±0.31	3.85 ±0.03	1.66 ±0.02	43.12 ±0.61
	1911	39.85 ±0.21	10.43 ±0.15	26.17 ±0.39	4.57 ±0.03	1.73 ±0.02	37.86 ±0.60

Excelsior II.,	1909	37.68 ±0.23	11.50 ±0.16	30.52 ±0.48	4.47 ±0.05	2.34 ±0.03	52.35 ±0.93
	1910	44.73 ±0.19	9.89 ±0.13	22.11 ±0.31	5.39 ±0.05	2.51 ±0.03	46.57 ±0.75
	1911	45.78 ±0.19	7.79 ±0.13	17.03 ±0.29	4.71 ±0.04	1.83 ±0.03	38.90 ±0.75
First of All,	1909	41.24 ±0.40	16.02 ±0.28	38 83 ±0.78	3.51 ±0.05	1.84 ±0.03	52.42 ±1.14
	1910	61.89 ±0.42	17.19 ±0.29	27.78 ±0.51	3.99 ±0.04	1.53 ±0.03	38.21 ±0.74
	1911	68.07 ±0.38	14.73 ±0.27	21.64 ±0.39	4.86 ±0.05	2.06 ±0.04	42.45 ±0.90
American Wonder,	1911	23.65 ±0.27	8.15 ±0.19	34.48 ±0.91	3.71 ±0.06	1.74 ±0.04	46.82 ±1.33
Early Prize,	1910	49.21 ±0.72	11.99 ±0.51	24.36 ±1.08	8.95 ±0.27	4.55 ±0.19	50.84 ±2.64
Gradus,	1911	52.29 ±0.56	15.50 ±0.40	29.64 ±0.82	2.18 ±0.04	1.14 ±0.03	52 54 ±1.67
Daniel O'Rouke,	1910	57.04 ±0.52	12.32 ±0.37	21.60 ±0.68	4.56 ±0.08	1.89 ±0.06	41.48 ±1.44
Thomas Laxton,	1910	59.46 ±1.47	19.68 ±1.04	33.10 ±1.93	3.83 ±0.11	1.48 ±0.08	38.65 ±2.32
Thomas Laxton,	1911	53.66 ±0.67	17.57 ±0.47	32 75 ±0.97	3.39 ±0.07	1.85 ±0.05	54.52 ±1.85
Alaska,	1910	64.99 ±0.32	14.88 ±0.23	22.90 ±0.37	3.61 ±0.03	1.41 ±0.02	39.09 ±0.68
Alaska,	1911	56.39 ±0.59	15.93 ±0.42	28.25 ±0.79	4.34 ±0.09	2.33 ±0.06	53.72 ±1.75
Evolution,	1911	72.14 ±0.61	16.56 ±0.43	22.91 ±0.63	4.52 ±0.10	2.65 ±0.07	58.71 ±1.96
Telephone,	1911	98.88 ±0.73	21.47 ±0.52	21.73 ±0.55	3.14 ±0.06	1.68 ±0.04	53.31 ±1.60
Champion of England,	1910	131.80 ±1.15	22.88 ±0.80	17.36 ±0.62	12.89 ±0.36	7.46 ±0.26	57.90 ±2.61
Champion of England,	1911	98.73 ±1.08	22 69 ±0.77	22.98 ±0.82	4.21 ±0.11	2.38 ±0.08	56.52 ±2.46

Considering first the figures for vine length, we find that in 1908 the standard deviation and coefficient of variability were much lower than in any of the following three years. This is due to two factors, the more potent of which, doubtless, was the soil of the plot on which the plants were grown; this was gravelly and the plants suffered severely from drought. The other was the small number of plants grown, the total of 1908 being 227, while in subsequent years the total of the same groups has been more than 1,000. During the years 1909–11 there seems not to have been in Excelsior I., or any of its sub-groups, any constant differences in variation that cannot be ascribed to seasonal influences. In Excelsior II. both constants are notably low in 1911. This may be due to the fact that they were planted later this year than previously and encountered the unusually hot weather of July, 1911, at an earlier stage of development than either the other lots of Excelsior, or this lot in earlier years had encountered the less severe midsummer heat of those years. A comparison of the two strains of Excelsior I. shows that A, D, F, G, K has had uniformly greater standard deviation than B, E, H, J, but this has not been in proportion to the higher mean, so the coefficient of variability is less in the longer vined strain. This same tendency is seen in the distinct varieties, although it is not invariably the case.

We may ask if the variation within the lines of the two strains of Excelsior I. give evidence of individuality of these several lines? Is any line constantly more or less variable than the others of the same strain? With the possible exception of line D, which has a standard deviation uniformly larger or at least as large as its fellows, there seems to be no evidence of such a condition of affairs. It appears that the differences in the variability within the different lines is mostly, if not entirely, environmental and due chiefly to varying soil conditions.

We may now turn our attention to the figures for the number of pods per vine. We see first of all that the coefficient of variability is nearly twice as large as that for vine length, and in many cases the difference is even greater than this. In general, a high variability in vine length is accompanied by a high variability of pods per vine and vice versa, as would be expected from the strong correlation already shown to exist between these

two characters. The differences in mean between different groups, more especially in different seasons, is marked. All through the groups of Excelsior I., 1909 was the most productive year, followed in order by 1911, 1910 and 1908. This order is not always followed in the other groups, owing to the fact that different planting dates and varying periods of growth caused the plants to experience different weather conditions at corresponding periods of development. These figures bring out in a striking way that fact familiar to all practical men, that productiveness is a delicate and uncertain character and tremendously influenced by environmental conditions.

The 10 plants of Excelsior selected in 1907 have given rise to at least three types of peas referred to as strains A, D, F, G, K and B, E, H, J and Variety " C." The groups Excelsior II. and First of All contain over 100 lines similar to those arising from these 10 plants, but in no case have we over 25 or 30 individuals in any one year. We may ask whether we have here any evidence of similar differences. No line is as distinct as Variety " C ", but whether there are any of the more similar types, such as the two strains referred to, cannot be positively determined, owing to the small number of individuals grown. If we admit the general application of the very low heredity coefficients shown in Table II. to all such lines, a coefficient materially greater than these must indicate the presence of distinct strains. Reference to Table I. indicates a possibility of such condition in the case of Excelsior II., but with First of All the figures are about the same as those for single lines; it should be remembered, however, that the indications are that the correlation between seed weight and vine length is less in starchy peas. A study of the means of single lines for the two years available has been made, but is of no value, as the variation obviously due to environment, and the small number of individuals grown, totally obscures any inherited likeness that may exist. The existence of a relatively large coefficient of variability should indicate the presence of distinct strains, but these figures for Excelsior II. and First of All are variable and inconclusive.

The conclusion on this point is that there is some evidence of the presence of distinct strains in both Excelsior II. and

First of All, though we cannot say that their presence in either group is conclusively proven. In the opinion of the writer only the growing of these lines in greater numbers, for a period of two or three years under the most uniform conditions possible, can determine whether they are homogeneous or are, like Excelsior I., made up of distinct strains.

Discussion of the Results.

This work deals with two somewhat distinct characters of the garden pea, — vegetative vigor as expressed by vine length and the reproductive power as expressed by the number of pods per vine. The former seems much the more stable character, while the latter is extremely variable and much the subject of environmental influences. Vine length is, therefore, more dependable in studying heredity. The figures for vine length seem to indicate that some and perhaps all varieties of garden peas are composed of strains which have different hereditary vine lengths, which is in harmony with much of the recent investigation along these lines. They do not, in the opinion of the writer, indicate that the progeny of each individual under observation form distinct units which may be distinguished from each other, but rather that there are comparatively few distinguishable units composed of individuals of equal hereditary value to be found within the limits of what we commonly understand as a garden variety.

This work indicates nothing as to the origin or permanency of these units or strains. They may have arisen by mutation, by a gradual differentiation or by hybridization; they may endure permanently or they may not. It will require much further investigation to settle these questions.

It is a little unfortunate that no records of the number and length of internodes have been kept, for they would probably throw light on certain questions of productiveness. Each node, excepting possibly the lower ones, may be considered a possible location for a pod. It is probable that whether or not a pod is produced from any given node is entirely a matter of environment. We see no reason to believe that the number of pods per vine is in itself inherited in any degree. Vine length and pre-

sumably the number of nodes may be in some degree inherited, and inasmuch as a longer vine, and presumably more nodes, gives more opportunities for pod setting, productiveness may be thus indirectly passed over from one generation to another; but we see no indication in this work, or any other with which we are familiar, that the ability to produce pods is an inheritable character.

It follows from this that in careful work in selecting for productiveness in peas it will probably be more effective to follow the indirect method of selecting the long vines rather than to select directly the more elusive and variable character of pods per vine.

The difficulties in the way of studying heredity in plants lie largely in differentiating the inherited variations from the environmental; they may be reduced to a minimum by securing as uniform conditions as possible and growing large numbers of individuals. In such ways we may hope to learn the laws of breeding and reduce its practice to a science.

SEED WORK FOR THE YEAR 1911.

G. E. STONE.

The seed work for 1911 has included, as before, seed germination, seed separation and testing for purity. The 355 samples of seed sent in for germination exceeded the number for 1910, and was the largest number received since the work was inaugurated. Sixty-eight samples were tested for purity, and 135 samples were separated. This is not the largest number ever received for separation; the weight in pounds, however — 6,320 — was four times as great as ever before. Eighty-seven samples of tobacco seed and 42 of onion were sent in for separation. The smaller number of samples received is due to a co-operation among the farmers in buying their seed.

The average germination of onion seed for 1911 was 70 per cent., the highest 98 per cent. and the lowest 20 per cent. The average for tobacco was 84 per cent., the highest 95 per cent. and the lowest 21 per cent., neither seed being quite up to the standard.

TABLE I. — *Records of Seed Germination, 1911.*

Kind of Seed.	Number of Samples.	Average Per Cent.	Per Cent. of Germination.	
			Highest.	Lowest.
Onion,	126	70.4	98.5	20.0
Tobacco,	11	84 9	95 0	21.0
Clover,	25	81.3	97.0	61 5
Rye,	5	84 5	97.0	63 0
Grasses,	38	77.7	99.0	15 5
Lettuce,	43	48 7	99 0	3.0
Celery,	21	30.2	91.0	–
Tomato,	9	58 3	98.0	–
Parsley,	5	56 4	85.0	20.0
Spinach,	7	28 0	39.5	12.0
Parsnip,	7	7.5	30.0	–
Miscellaneous,	65	42.8	98 5	–
	355	–	–	–

More seed separation is apparently being done at this station than at any other, and this work is constantly increasing. The advantages to be derived from seed separation are not fully appreciated as yet. Onion and tobacco growers, we believe, are realizing these advantages more fully year by year, and this is true of some lettuce and celery growers, but much more use could be made of the practice by market gardeners. Seed separation results in better seed, more perfect germination and much more uniform and larger plants, which in seedbeds saves space and a great deal of labor in selecting uniform seedlings.

The selection from strains is also being made much of in the growing of corn and other crops, but market gardeners and farmers are by no means making use of all the opportunities in any of these directions.

TABLE II. — *Records of Seed Separation, 1911.*

Kind of Seed.	Number of Samples.	Weight (Pounds).	Per Cent. of Seed retained.	Per Cent. of Seed discarded.
Onion,	42	6,206 210	72 1	27.9
Tobacco,	87	85.820	86.3	13.7
Lettuce,	3	27.720	83.6	16.4
Celery,	6	.926	84.8	15.2
Total,	135	6,320.676	-	-

The percentage of onion seed discarded runs higher than usual, a fact due, apparently, to the relatively larger number of small seeds present than usual.

A summary of the seed work carried on at the station for a period of twelve years is shown in Table III. Previous to 1899 little seed testing and separation were done here, and no systematic records were kept of the work. Table III. gives a recapitulation of the work done in seed germination, purity testing and seed separation since 1899.

TABLE III. — *Showing Number of Samples of Seed Purity and Germination Tests made, and Seed Separation Work done, at the Station since 1899.*

Year.	Number of Samples.			Pounds separated.
	Germination.	Purity.	Separation.	
1899,	27	-	-	-
1900,	17	-	-	-
1902,	53	-	-	-
1903,	42	-	-	-
1904,	131	-	-	-
1905,	217	-	-	-
1906,	126	18	87	144
1907,	247	27	112	472
1908,	196	12	160	1,370
1909,	273	100	143	1,501
1910,	296	30	115	1,552
1911,	355	68	135	6,320
Total,	1,980	255	752	11,359

This table gives some idea of the increased interest manifested in seed work by the farmers and market gardeners of the State. Nearly 2,000 tests have been made for germination. 255 tests for purity, and 752 separations made. The total weight of seeds separated is 11,359 pounds. It must be remembered that all the seeds separated were small, particularly tobacco seed, of which it requires a great many to make a pound. A record of the number of samples, with the average, maximum and minimum germination of onion, tobacco and celery seed, is shown in Table IV.

TABLE IV. — *Showing Germination of Onion, Tobacco and Celery received at the Station since 1899.*

Year.	Onion.				Tobacco.				Celery.			
	Number of Samples.	Average.	Maximum.	Minimum.	Number of Samples.	Average.	Maximum.	Minimum.	Number of Samples.	Average.	Maximum.	Minimum.
1899, . .	27	72.0	90.0	45.0	–	–	–	–	–	–	–	–
1900, . .	12	85.6	92.0	70.0	–	–	–	–	–	–	–	–
1902, . .	6	89.0	94.0	83.0	–	–	–	–	–	–	–	–
1903, . .	21	85.5	97.0	52.5	–	–	–	–	–	–	–	–
1904, . .	25	77.8	96.5	45 5	–	–	–	–	–	–	–	–
1905, . .	15	91.8	98.5	84.0	–	–	–	–	4	89.0	97	79
1906, . .	32	79.0	100.0	28.0	–	–	–	–	6	67.0	99	43
1907, . .	40	86.0	98.5	57.0	2	91.0	92	90	3	83.0	91	70
1908, . .	65	74.2	98.5	–	10	78.0	97	20	24	79.0	98	35
1909, . .	92	82.2	97.0	25.0	8	93.6	97	85	8	69.0	85	25
1910, . .	75	77.4	100.0	3.0	7	95.0	99	89	–	–	–	–
1911, . .	126	70.4	98.5	20.0	11	84.9	95	21	21	30.2	91	–
Total, .	536	–	–	–	38	–	–	–	66	–	–	–

During the period from 1899 to the present time 536 germination tests of onion seed, 38 of tobacco and 66 of celery have been made, representing about one-fourth of the seed which we have tested. The principal feature to be noted is, perhaps, the variation in the percentage of germination occurring from year to year in different seeds. While it is perhaps not legitimate with the data at hand to draw too close deductions, we have noted in our seed work the effects of unfavorable climatic conditions upon the size and weight of seeds and seed vitality. The lowest average for onion seed was obtained in 1911, most of this seed probably having been grown in 1910; the highest average germination for onion in 1905, and for tobacco in 1910. The tobacco seed are practically all grown in the Connecticut valley, and obtained from carefully selected plants the year before. The variation in vitality is of some significance here. The celery seed tested is of uncertain origin, and the variation has little

significance for us. There is no doubt but that unfavorable seasons and other factors show their effect in the percentages of germination given in these tables. In the case of tobacco seed another factor probably enters in, viz., gradual improvement in the vitality brought about by care in the selection of the seed plants.

TABLE V. — *Showing Number of Samples and Pounds of More Important Varieties of Seeds separated from 1906 to 1911, inclusive.*

Kind of Seed.	Number of Samples.	Weight (Pounds).	Per Cent. of Seed retained.	Per Cent. of Seed discarded.
Onion,	187	8,923.30	83.6	16.3
Celery,	29	555.64	89.3	10.7
Tobacco,	418	272.43	85.4	14.6
Lettuce,	6	67.72	86.8	13.2
Total,	640	9,819.09	–	–

In Table V. is shown the number of samples and pounds of four typical seeds, with the percentage retained and discarded in our separation work, covering a period of five years, from 1906 to 1911. It will be seen from this table that the total number of samples separated is 640, equalling nearly 10,000 pounds in weight. The average percentage discarded was about 15 per cent., representing small, inferior seeds. Since these were all small seeds the weight in pounds is rather insignificant, as the number of onion seed in a pound is approximately 130,000, that of celery seed 2,000,000, of lettuce, 400,000 and of tobacco 7,000,000. All the seed work has been done here gratuitously since its inauguration, the only exception being in the case of retailers who sometimes wish their seed tested in large quantities. The only expense incurred by the grower at present is return postage or express charges, and we are glad to say that this condition is almost invariably complied with.

In our opinion this work has proved of great value to our agriculturists. So far as seed separation is concerned, the value is greater than some of them realize, and perhaps less than others of the more enthusiastic may believe. The many careful tests which we have been making for years have shown us what

seed separation actually accomplishes, and we therefore desire neither to overrate nor underrate the value of the work. The seed work of this station has shown a very healthy increase and growing interest on the part of the farmers. It has not been extensively advertised nor the value exaggerated, as we have regarded a slow, constant growth as of more value than one of a sporadic nature. The work, however, is now becoming so important in our State that it requires the services of a seed analyst who would devote most of his time to this work. We are of the opinion that this work should be done gratuitously for farmers and citizens, for the present at any rate, as it is more or less educational in nature, and that provision should be made for an assistant and improved testing appliances. Constant experimentation should be carried on to improve upon the existing methods of germination and separation. The work should be done systematically and collections of samples obtained throughout the State from dealers and farmers, and the results of these tests published here in bulletin form. This would greatly improve the seed problem as existing in this State.

All samples of seed to be germinated or separated should be sent to G. E. Stone, Massachusetts Agricultural Experiment Station, Amherst, Mass., and the express or freight should be prepaid.

RUST ON VINCA.

G. E. STONE.

An outbreak of rust on Vinca was recently brought to our attention by Mr. O. C. Bartlett, a graduate student at this institution. Mr. Bartlett, who is engaged in the summer in inspection work, became acquainted with this trouble through J. W. Adams & Co., of Springfield, Mass., a firm which maintains a nursery and general greenhouse establishment. The rust appears to be new in this country, and is apparently the same species as that occurring in Europe on Vinca,[1] although the specimens obtained by us do not correspond in every way to the European descriptions of this fungus. We have in our herbarium no European species with which to compare our specimens, but they were sent to Prof. W. G. Farlow, of Harvard University, and to Dr. J. C. Arthur of Purdue University, Indiana, who is a rust specialist. Professor Farlow writes that from a casual examination of material which we sent him, and which he compares with material in his own herbarium, the species differs considerably from his own type, *Puccinia Vincæ (DC) Cast.* Dr. Arthur states that there are two distinct forms in Europe, both of which are referred to as *Puccinia Berkelei, Pass.*, and *Puccinia Vincæ (DC)*, Berk., the former being a synonym of the latter, and that the specimens sent correspond with one of the European types.

The rust has apparently been present in the vicinity of Springfield and Chicopee for at least two or three years, corresponding to the period when there was more or less of an unusual epidemic of rust in this State and elsewhere. Vinca is grown out of doors during the summer from greenhouse cuttings, but we could find no evidence of the disease affecting

[1] Tubeuf & Smith, "Diseases of Plants," p. 356.

outdoor plants in the summer or early fall. It makes its appearance in the greenhouse in the late fall and persists during the winter, affecting the leaves of the young, vertical shoots more seriously than those of the older, pendant ones. We observed both the euredospore and teleutospore outbreaks, which occurred on the underside of the leaves on our material. In the spring it appears to affect the plants less seriously, probably owing to the practice of frequently cutting off the affected parts and destroying them, and to the vigorous growth of the plants in the spring. When starting new plants care has been taken to use only healthy cuttings from year to year, and in this way the rust has, perhaps, been held in check to some extent.

The disease affects both the green and variegated varieties, although the latter are usually more severely affected. It has been found on a large number of plants, but the loss has not been serious owing to a tendency on the part of the plants to outgrow the trouble.

We have not been able to learn whether the mycelium is perennial in the stem or not, or whether infection comes from the field, but the rust does not seem to be so serious this year as the past two years, agreeing in this respect with other rusts which have been more or less epidemic. If the infection occurs on outdoor plants, as in the case of chrysanthemum rust, it can easily be controlled by indoor or tent-cloth culture, or by any other means which would keep the dews off the plants, and even if the mycelium is present in the stem to some extent the disease can no doubt be practically controlled by careful selection of cuttings. We have been unable to trace the disease beyond the points mentioned. The stock in use was obtained from the immediate neighborhood where the infection occurred, although no doubt the rust at some time or other came in on stock imported from Europe.

FROST CRACKS.

G. E. STONE.

Many trees of different varieties are subject to frost cracks. These often remain open for several years, and so far as our observations go are almost always to be found on the sunny side of the tree, generally towards the south. They occur in winter, and it is generally believed that they are caused by sudden changes in temperature, and especially by very severe cold. They were very common in this section during the remarkably cold winter of 1903–04, when some fruit trees, 8 or 10 inches in diameter, had frost cracks which opened 4 or 5 inches wide.

In this section the elm tree is more liable to cracks from the action of frost than other varieties. These are often 12 or 15 feet long, and give rise to more or less serious bleeding during the summer months. Cracks in trees occur not infrequently from other causes, such as the splitting of limbs, and we have known a number of sugar maples to gradually bleed to death from the loss of sap.

Frost cracks open in winter when the temperature is low, and close in summer. When not very large they sometimes heal over and disappear through the activities of callus growths, but more often they persist for some years, and an extensive opening of the cavity prevents permanent healing, making the tree subject to bleeding in summer.

Frost cracks are difficult to treat satisfactorily by tree surgery methods, as they often extend quite deeply into the wood, and the orifice is constantly changing in width owing to changes in the temperature. For the same reason certain other cavities in trees are hard to treat, as they sometimes open in winter and allow water to enter, which often results in the displacement of the cement fillings. To obviate this difficulty we have experimented largely with elastic cement applied to the edge of the

filling as a means of preventing the access of water between the cement and the wood, but have found it practically impossible so far to prevent the bleeding of frost cracks or cavities in trees. There is no substance now in use which can successfully overcome the pressure exerted by the sap, which is bound to exude under certain conditions.

During the winter of 1907 Mr. E. G. Bartlett, at that time assistant in the laboratory, at my suggestion made measurements of the opening and closing of the orifices of some large frost cracks on the south side of elm trees located on the college campus. In the following table are given the results of these measurements, together with the mean temperature for the same period. The meteorological data were taken from the local station on the college grounds, and not a great distance from the trees.

Table showing Variation in the Width of Frost Cracks in Elm Trees (Ulmus Americana).

Date.	Tree No. 1.	Tree No. 2.	Mean Temperature (Degrees F.).
February 4,	23	20	16.5
5,	24	21	11.0
6,	26	24	5.3
7,	32	28	2.5
8,	28	24	16.0
9,	26	23	13.0
11,	22	18	17.0
12,	36	32	1.3
13,	38	35	2.5
14,	24	20	31.7
15,	26	22	28.5
16,	21	17	26.7
18,	22	20	21.5
19,	22	18	14.5
20,	22	18	30.7
21,	25	21	20.5
22,	28	24	8.0
23,	32	28	.5
25,	22	28	20.3

Table showing Variation in the Width of Frost Cracks in Elm Trees (Ulmus Americana) — Concluded.

Date.	Tree No. 1.	Tree No. 2.	Mean Temperature (Degrees F.).
February 26,	28	24	7.7
27,	29	25	12.0
28,	28	24	7.5
March 4,	20	16	27.5
5,	20	16	21.3
6,	20	16	23.7
7,	21	17	22.5
8,	20	16	24.0
9,	20	16	23.7
10,	21	17	20.5
11,	20	16	29.7
12,	18	14	25.5
13,	18	14	37.3
15,	11	8	35.7
17,	9	9	41.7

Measurements were not taken on February 10, 17 and 24 (Sunday). The remainder of March the cracks were too small to measure conveniently.

In the following diagram are shown graphically the variations in the opening and closing of frost cracks based upon the average measurements of tree No. 1 and No. 2; also the barometer, mean temperature and mean relative humidity curve.

It will be noticed that the barometer and temperature curves coincide closely with those given by the opening and closing of the frost cracks, and the same is true to a certain extent of the curve given by the relative humidity. The temperature curve is based upon the mean of the maximum and minimum for each day.

During the periods of low temperature the cracks opened, and closed when the temperature was higher. They open wider in February than in March, as shown by the higher readings in the table.

The relative mean humidity curve in general corresponds with that of the opening and closing of the frost cracks. When

the humidity is low the cracks show a tendency to open, and to close when the humidity is great. The rise and fall of the

Showing curve of opening and closing of frost cracks in elm trees. The lower curve represents the variations in the opening and closing (scale, 1/64 of an inch); the others represent the mean relative humidity, mean temperature and barometer in the order named.

barometer curve coincides very closely with that of the frost cracks; in fact, there was such a close relationship between the temperature and barometer readings and opening and closing

of frost cracks that considerable information as to the weather conditions might be obtained from observations on frost cracks. During the latter part of March, when the temperature was higher, the frost cracks did not open so wide, and it became more difficult to read them accurately. The same degree of variation in frost cracks may not occur in the summer months as in the winter; at any rate, the change was not so noticeable.

A NEW METHOD FOR THE APPROXIMATE MECHANICAL ANALYSIS OF SOILS.

G. E. STONE AND G. H. CHAPMAN.

According to the best authorities, and giving the definition used by the authors of Bulletin No. 24 of the United States Department of Agriculture, "The mechanical analysis of a soil consists in the separation of the soil particles into groups dependent upon the size of the grains, and in the determination of the percentage by weight of the particles constituting each group. The limits of these groups are arbitrarily chosen with reference to the ease in making the separation, and to the importance of the particles of any given size in determining the physical characteristics of the soil."

Many methods have been devised at different times by investigators, but the whole matter was somewhat hazy on account of each one using his own measurements for grading the soil particles, etc., until the present method of centrifugal analysis was devised by the authors of the bulletin previously noted. Since that time the methods described therein have been made use of by the United States Department of Agriculture and the experiment stations in general, where absolutely accurate results are desired for all characters of soils.

The chief objection to the methods heretofore devised has been the length of time necessary to carry through an analysis, even of the simplest soil.

In the work of this station there have arisen many occasions when it would have been of great advantage to know approximately the composition of a soil, more particularly of those used in greenhouses and market gardening. With a large amount of other routine station work always on hand it was found impossible to devote the time necessary to make an analysis of the soil samples by the ordinary centrifugal, or as we shall hereafter

call it, the "long" method, so it became necessary to devise a method which would materially shorten the process and still give accurate results within a reasonable limit of error.

After considerable experimentation a satisfactory method was devised and has been used with success in our work here the past year. It is not claimed that this method is absolutely accurate, nor is any for that matter, as the limit of error, even when using the most approved centrifugal methods where the greatest care is used, is admittedly large, dependent somewhat of course on the manipulator.

A great number of comparisons have been made of the results obtained by analysis of soils by the long method and the short method and are given in the following pages. The method used by us is more or less of an adaptation of the centrifugal method in general use.

In brief, the centrifugal method in general use is as follows: the soil is carefully sampled and a part of the sample which passes through a 2-millimeter sieve is used for analysis. Five grams are usually taken and dried at 110° C. This sample is then shaken with water, to which a few drops of ammonia have been added, for six hours or more. The sample is then placed in tubes and centrifuged until all but the clay particles have subsided; these, with the water, are then decanted off and evaporated to dryness and weighed. The silts are found by allowing everything larger in size than .05 millimeter to subside, decanting the liquid, evaporating, drying and weighing. The remaining sands are dried and weighed and then sifted by four sieves into five grades. The organic matter is determined usually by the chromic acid method, but should not be confounded with the "loss on ignition" which is often erroneously termed organic matter.

This process, as can plainly be seen, takes a long time to carry through, and is not applicable where quick results are desired.

The briefer method in use at this station is as follows: the sample of soil as brought to the laboratory is first thoroughly mixed and then dried at 110° C. It is then sifted through a 2-millimeter sieve and all that passes through is classed as soil. This is again mixed and 10 grams taken for analysis. This is heated to obtain the "loss on ignition," in a platinum or porce-

lain crucible, and the organic matter, water, etc., is driven off. The sample is then cooled and weighed and loss of weight recorded as "loss on ignition." It is then placed in a small mortar and rubbed gently with a medium hard rubber-tipped pestle to disintegrate the soil particles as far as possible. Then the sample is sifted carefully with constant brushing with a stiff camel's hair brush through 1-millimeter, .5-millimeter, .25-millimeter and .1-millimeter sieves, the last two being bolting cloth, as in the long method. The residue remaining consists of the very fine sand, the silts and clay. This remainder is weighed and the weight recorded, and one gram or fraction thereof is weighed out and used in the remainder of the process to determine the percentage of very fine sand, silts and clay.

This determination is made in the following piece of apparatus (see Fig. 1): A is a circular test tube having a diameter of approximately 2 centimeters and a length to the contraction of about 7 centimeters; B is a flat glass tube with thin walls,

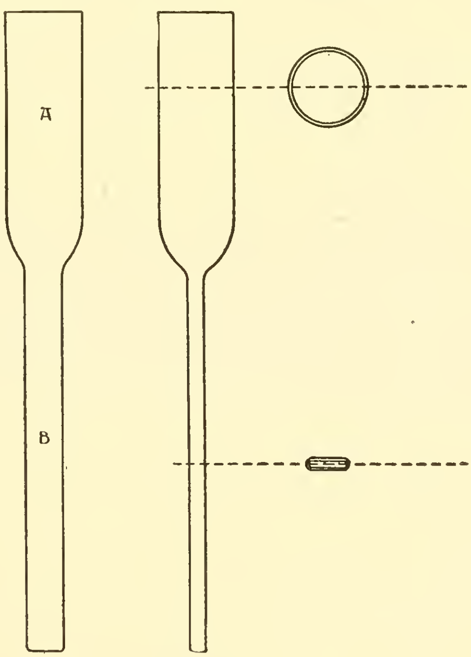

Fig. 1. — Showing special tube for mechanical analysis of soils: *A*, upper or circular part of the tube; *B*, lower or flat part of the tube. The figures to the right show cross sections, etc., of the tube.

one of which at least is perfectly flat, having an inside breadth of .8 centimeter and a width 1 to 1.5 millimeters. This tube is about 10 centimeters long. The lengths of A and B may be varied, however, but it has been found that tubes of these dimensions work well in the ordinary laboratory centrifuge. The method of procedure is as follows: the tube is filled to within about 4 centimeters of the top with distilled water and the gram of soil added. A rubber stopper is then placed in the tube and the soil thoroughly incorporated with the water by shaking for a few minutes. The tube is then placed in the centrifuge and run for a period of five minutes at a speed of about 1,200 revolutions per minute. The tube is then removed and clamped to an upright stand shown in Fig. 2, and a millimeter scale is attached so that with a horizontal microscope the size of the soil particles as shown by the eyepiece micrometer and the reading on the scale may be had at the same time or by swinging the microscope in a horizontal plane. 0 millimeter on the scale corresponds with the bottom of the soil column in the tube. The microscope is then focussed on the soil particles and raised until a majority of the particles are less than the minimum size of those of fine sand, *i.e.,* less than .05 millimeter; the scale reading is then taken and noted. The microscope is then raised until the particles are less than those of the minimum size for silts, viz., .0005 millimeter; the scale reading is again noted and the scale reading at the top of the soil column also noted. We have the readings as follows: —

	Millimeters.
Very fine sand,	3.0
Very fine sand and silts,	4.5
Very fine sand and silts and clay,	7.0

The column is divided, therefore, into volume per cents. as follows: —

	Per Cent.
Very fine sand,	42.85
Silts,	21.43
Clays,	35.72

If there were 2.34 grams of soil left after the last sifting we should have weights of very fine sand, silts and clays as follows,

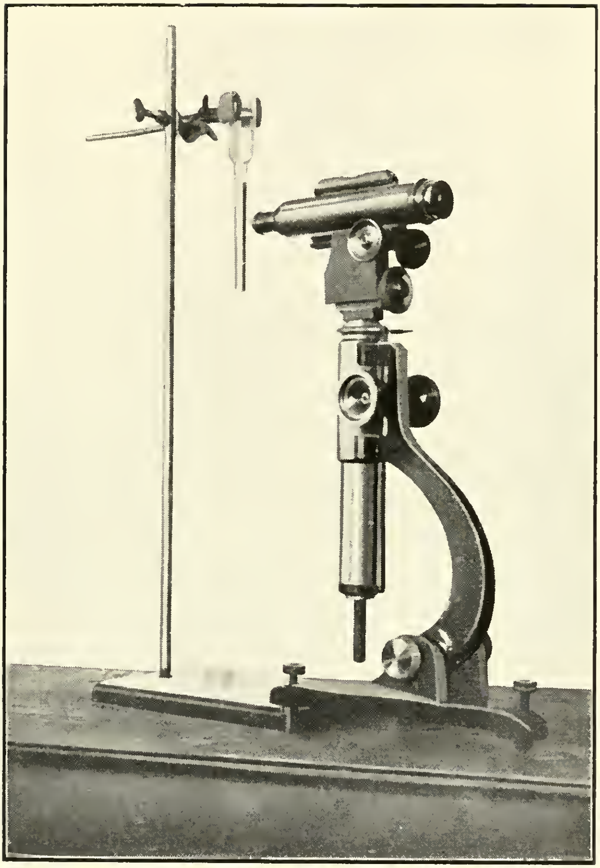

Fig. 2.—Photograph showing a horizontal microscope and methods of reading different percentages of soils in the tube.

using these volume percentages as weight percentages, which may be done, as experiment has shown that in the small tube the error is not great enough to be taken into consideration.

Very fine sand $= 2.34 \times 42.85$ per cent. $= 1.00 +$ grams.
Silts $= 2.34 \times 21.43$ per cent. $= .49 +$ grams.
Clay $= 2.34 \times 35.72$ per cent. $= .84 +$ grams.

Thus we have the weights of the very fine sand, silts and clay, and by following the same system used in calculating the percentages of the sands obtained by sifting in the whole sample we get the percentages of these constituents.

Below are given results of several typical soils which were analyzed by the long method and by the short method. It will be seen that the results vary but little and that for a close approximate analysis the results are accurate enough to warrant the use of this method where time is an important factor.

A criticism of this method may be raised, but its accuracy and ease of manipulation cannot be doubted, as it has been repeatedly proved to give as good results for general use as the long method, and in about half the time. Soils were analyzed by outside parties, and then the same soils were analyzed in the laboratory by the shorter method, and the results were well within the acknowledged limit of error, as can be seen from the following table: —

Table showing the Results obtained on Various Soils from Analyses by the "Long Method" and by the New Method.

[Per cent. of organic matter, gravel, sand, silt and clay in 20 grams of soil.]

Number.	Organic Matter.	Gravel (2–1 mm.).	Coarse Sand (1–.5 mm.).	Medium Sand (.5–.25 mm.).	Fine Sand (.25–.1 mm.).	Very Fine Sand (.1–.05 mm.).	Silt (.05–.01 mm.).	Fine Silt (.01–.005 mm.).	Clay (.005–.0001 mm.).	
55, . .	2.30	5.33	17.70	10.13	11.97	14.08	23.43	4.49	3.58	Long method.
	4.93	8.33	15.60	12.37	12.95	15.84	26.14		3.56	Short method.
49, . .	7.44	6.55	9.20	4.23	23.52	22.36	15.89	3.92	5.12	Long method.
	8.70	6.03	8.76	9.74	20.84	21.11	17.66		4.94	Short method.
54, . .	5.37	0.03	0.20	0.25	6.30	37.87	32.85	5.12	5.01	Long method.
	6.54	0.00	0.00	0.60	10.21	41.12	32.59		7.34	Short method.

There are admittedly several places where orthodox ideas have been differed from, but we have been unable to detect any bad effects as the result of these differences. The breaking up of the soil after beating in the mortar with a medium hard rubber pestle is one of these, and while error might creep in by careless or thoughtless manipulating, it is believed that with care any appreciable error can be easily obviated.

As there is a limit of error of from 2 to 5 per cent. by the long method in an analysis of the same soil, and as we came well within this limit in every case, we believe that we are justified in using this method for the breaking up of the soil particles.

In all probability it may not break up all the agglomerates, but so far in our experience the method has given perfectly satisfactory results, when reasonable care is used.

There may also be a slight loss of the finer particles in the sifting, but no more than is usual even by the long method.

In conclusion it may be said that where absolute accuracy is desired we do not recommend this short method, but for a close approximation it works very well.

FIG. 1.—Showing the effects of soil sterilization on the growth of melons. Two plants at the left grown in unsterilized loam; those at the right in the same loam sterilized.

THE PRESENT STATUS OF SOIL STERILIZATION.

G. E. STONE.

The term "soil sterilization" has long been applied by commercial growers to a system of heating soils, generally by the use of steam, to a temperature ranging from 180° to 212° F. for the purpose of destroying certain disease germs. In practice the heat is applied for only a short time, and as a matter of fact, only a comparatively small number of bacteria are destroyed. The process as usually employed by commercial men merely accomplishes what is termed "pasteurization."

The stimulating effects of sterilized soil on plant growth have long been recognized, and some large growers of lettuce and other crops have made extensive use of the practice largely for the effects produced on plant growth. Even as a young boy I remember observing the peculiar stimulating effects sterilized soil had on plant growth where charcoal pits had been burned. The soil and turf used in covering coal pits in the process of making charcoal are steamed and heated for many days, and become thoroughly sterilized. When the charcoal is taken out the soil is left spread out, and it often supports a vigorous and rank vegetation.

The extensive experiments which we made some years ago demonstrated that crops growing in sterilized soil are greatly stimulated; some crops, and lettuce in particular, showing the effects much more than others, however. This stimulation makes a different handling of lettuce necessary, and lower night temperatures must be maintained so that the characteristic heads will form properly and topburn be prevented.

Our experiments showed that while sterilization gives beneficial results with certain soils rich in organic matter, other soils

deficient in this respect may cause injury to the crop when sterilized.

We have maintained that the benefits resulting from soil sterilization are largely chemical in nature, as shown by experiments with seeds, etc. In two series of experiments,[1] in which a large number and several varieties of seeds were employed, we found not only a marked acceleration in germination, but considerable increase in the number of seeds that germinated in sterilized soil when compared with the same soil unsterilized. The stimulating effects produced in these tests were undoubtedly chemical in nature; that is, there were certain substances in the soil which were chemically changed by the process of steaming, and these being absorbed by the seed, increased germination followed. It is, however, not at all improbable that part of the stimulating effects on seeds grown in sterilized soils is due to the renovation of the gases contained in the soil, since the old gases are driven out by the process of steaming. Steaming, in other words, has to a certain extent the same effect as aerating the soil, which process greatly stimulates seed germination and growth. In one experiment where 3,000 lettuce seed were grown in two boxes, 1,500 in each box and one being aerated and the other not, it was found that 86 per cent. germinated in the aerated soil, while only 64 per cent. germinated in the unaerated soil. The average weight of seedlings was 46 per cent. greater in the aerated than in the unaerated soil.[2]

Our experiments [3] in germinating seeds in decoctions of sterilized soil showed that the decoctions exerted a chemical stimulation, and that even decoctions from unsterilized loam had a similar effect on germination. The soil we used had never received any commercial fertilizer, but was a typical market-garden soil, frequently enriched with decomposed horse manure. It is well known that a great variety of chemicals stimulate seed germination, and it is not surprising that decoctions of soils would do the same.

The increase in the number of bacteria in sterilized soil has

[1] Hatch Exp. Sta., 15th Ann. Rept., 1903, p. 41; also Hatch Exp. Sta., 18th Ann. Rept., 1906, p. 126.

[2] Hatch Exp. Sta., 18th Ann. Rept., 1906, p. 124.

[3] Hatch Exp. Sta., 18th Ann. Rept., 1906, p. 129.

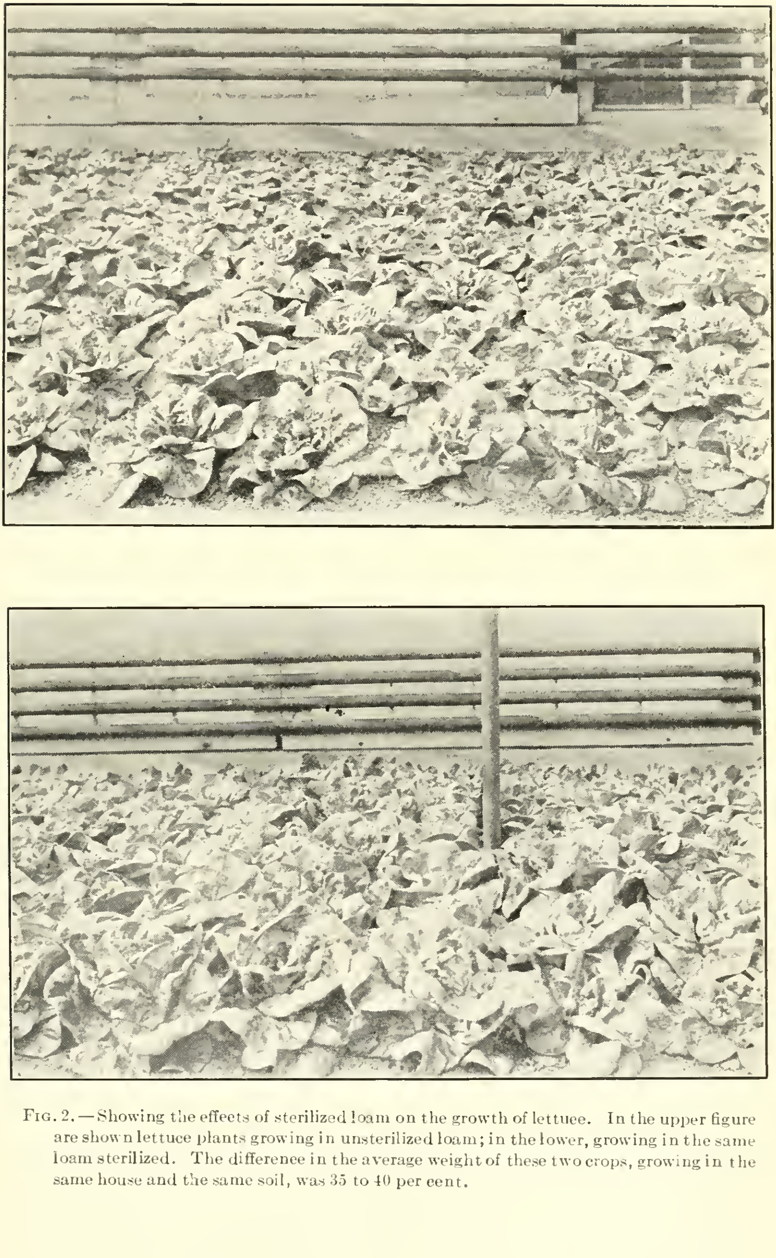

Fig. 2.—Showing the effects of sterilized loam on the growth of lettuce. In the upper figure are shown lettuce plants growing in unsterilized loam; in the lower, growing in the same loam sterilized. The difference in the average weight of these two crops, growing in the same house and the same soil, was 35 to 40 per cent.

been demonstrated by Prof. A. Vincent Osmun [1] and others, and the interpretation of these results we believe can be found in chemical stimulation. However, it is not at all unlikely that even in this case the aeration of the soil resulting from steaming may play a small rôle in the increased number of bacteria, since it is known that cultivation gives rise to an increase in the number of bacteria in soils.

There are great differences in soils as regards the stimulating effects of sterilization, and judgment must be exercised in drawing deductions from this fact alone. Many commercial florists and market gardeners in various parts of the United States have had some experience in growing different crops in sterilized soil, and the results of their experience in this work are not always the same. The best results which we have observed as arising from sterilization have invariably been given by lettuce.

The soils used in growing lettuce are rich in organic matter from the repeated application of horse manure year after year, and it is such soils as these, rich in humus, that sterilization affects most advantageously for plant growth. Some experiments, however, which we have made, with decomposed leaves (leaf mold) and decayed vegetable matter obtained from florists, gave results somewhat different from those obtained from soils rich in organic matter largely derived from horse manure. When seeds were soaked in decoctions of either sterilized or unsterilized leaf mold they showed little or no stimulation, and when the decoction was strong we obtained positive injury to seed. Neither did we obtain any stimulus to crops in sterilized forest humus except when the humus was first washed out and then sterilized.

The idea recently advanced by Russell and Hutchinson, that the increased bacterial flora characteristic of sterilized soil is biological rather than chemical, does not in the least appeal to us, at least for our conditions. The theory is to a certain extent an adaptation or application of the Metchinikoff phagocyte theory to the soil. Russell and Hutchinson report finding protozoa devouring bacteria in the soils, and they account for the increase of bacteria in sterilized soils by the absence of protozoa

[1] A Comparison of the Numbers of Bacteria in Sterilized and Unsterilized Soils, by A. Vincent Osmun, Hatch Exp. Sta. Rept., 1905.

and allied forms of animal life which prey upon micro-organisms.

It would be unjust for us to affirm what might take place in the soils of England or those on the continent, and it is to be assumed that the soil and climate, as well as the biological conditions, are different from those here; nevertheless, we are convinced that the biological theory does not hold in the soils we have experimented with for years, and as far as we are able to determine it possesses no significance. The matter, however, will be discussed in the following article prepared at our suggestion by Messrs. Smith and Lodge. These investigations were made under our direction in our laboratory during 1910 and 1911, when the men were taking senior work in the college, and prove to our satisfaction that protozoa, at least in our soil, have little or no part in accounting for the increased number of bacteria in our soils, although we cannot affirm that they do not play a more important rôle in England and elsewhere.[1]

The stimulating effects which sterilized soils have upon bacteria are chemical in nature, and so far as we can determine with our soils biological factors exert no influence in this respect. Most observers, we believe, agree that ammonia is given off from sterilizing soils, owing apparently to dentrification, and in this connection we might relate that in some cases where horse manure was applied freely and sterilization followed we noted that if certain plants, such as tomatoes, were transplanted in the soil too soon after the sterilizing had been done, their leaves would present symptoms of ammoniacal burning.

The sterilizing of soils has been carried on very extensively for some years in this country, particularly in greenhouses, and we have had opportunities to observe various crops growing in many acres of treated soil. In practically all cases moist heat, that is, steam, is employed for this purpose, although hot water has been used with practically the same results. There are, as might be expected, a variety of opinions as to the effects which stimulation has upon plants, since a large variety of soils have been treated, and the crops have been grown under very variable conditions. Moreover, as has already been stated, some crops

[1] Mr. David Larsen, who is associated with the Hawaiian Sugar Planters' Experiment Station in Honolulu, informs me that protozoa are quite abundant in Hawaiian soils, and that carbon bisulfid applied to the soils there acts as a great stimulus to crop production.

are stimulated much more than others by this treatment. Most crops require special handling in sterilized soils, otherwise trouble is likely to follow.

Many different methods of sterilizing soils have been developed, and the writer has experimented with practically everything there is in this line. There is no doubt that many soils can be greatly improved by sterilization, and in the future it will be more extensively employed not only for the destruction of pathogenic organisms, but, like electricity and other stimuli, as a means of hastening crop production.

The writer at one time had experience with a soil which would not grow lettuce. When it was sterilized, however, no further difficulty was experienced with it. Even muck soils, which are rich in organic matter and generally injurious to plant growth, can be greatly improved by leaching and sterilizing.

In the south there are many acres of soil seriously affected with Sclerotinia which can be treated effectively at no great cost, and in the future soil sterilization is bound to become of practical use for field work. There is no reason why methods cannot be adapted for cheap and effective sterilizing of outdoor soils if the land be fairly level and free from stone.

INFLUENCE OF SOIL DECOCTIONS FROM STERILIZED AND UNSTERILIZED SOILS UPON BACTERIAL GROWTH.

C. A. LODGE AND R. G. SMITH.[1]

An attempt has been made in the following experiments to ascertain the cause underlying the effects which sterilized and unsterilized soil decoctions have upon bacterial development. These questions have often arisen: In what manner does soil sterilization affect bacterial development? Is the cause underlying the development of bacteria in soils of a chemical or biological nature? Some investigators maintain that the increase of bacteria in sterilized soils is due to a chemical stimulus, while others insist that it is biological; *i.e.,* that minute animal organisms known as protozoa affect the bacterial flora of soils. In all probability the chemical factor is the important one, the biological factor playing little or no part in either increasing or retarding bacterial growth, at least in any of our soils.

We selected for use in our experiments two types of soils, — one an Amherst greenhouse soil or loam, somewhat modified by the addition of coarse sand and quite rich in organic matter, and which will be designated as loam; and the other a yellow loam or a typical Amherst subsoil, deficient in nitrogen and containing only a slight amount of organic matter, which will be designated as subsoil.

TABLE I. — *Showing Mechanical Analysis of Two Types of Soils used in these Experiments.*

[Per cent. of organic matter, gravel, sand, silt and clay in 20 grams of soil.]

	Organic Matter.	Gravel (2–1 mm.).	Coarse Sand (1–.5 mm.).	Medium Sand (.5–.25 mm.).	Fine Sand (.25–.1 mm.).	Very Fine Sand (.1–.05 mm.).	Silt (.05–.01 mm.).	Fine Silt (.01–.005 mm.).	Clay (.005–.0001 mm.).
Loam, . . .	10.45	13.97	24.48	17.33	21.60	20.00	5.00	1.50	.12
Subsoil, . .	3.60	1.75	4.45	6.95	23.85	35.95	11.10	5.20	5.25

[1] This work was done at the instigation and under the direction of Dr. G. E. Stone when Messrs. Smith and Lodge were seniors in the college.

The soil decoctions used in our experiments were made as follows: four hundred grams of soil were placed in a percolation tube and lukewarm distilled water was allowed to percolate several times through the soil. This method was followed in each instance. The decoctions thus made (the percolated water) were then placed in flasks, each flask containing 100 cubic centimeters of percolate. Then these decoctions, composed of percolates from sterilized and unsterilized soils, were placed in the autoclave and subjected to steam pressure of 15 pounds for forty-five minutes at a temperature of 250° F.

Three series of experiments were carried on with each soil. In series No. 1 a sterilized and unsterilized loam were used, and the sterilized decoctions inoculated with ordinary soil bacteria. In the second series of experiments a sterilized and unsterilized loam. and in addition a sterilized and unsterilized subsoil, were used, and the sterilized decoctions inoculated with ordinary soil bacteria. In our third series of experiments a sterilized and unsterilized loam and subsoil were used, as in our second series of experiments, but with this difference, — inoculations were made from a pure culture of Bacillus subtilis. In the above series of experiments, where a sterilized loam or subsoil was used, sterilization was done as follows: about 1 liter of soil was placed in the autoclave and subjected to steam pressure of 15 pounds for forty-five minutes at a temperature of 250° F.

The following method of inoculation was used in our first two series of experiments, where ordinary soil bacteria were used. Ten grams of loam were placed in 100 cubic centimeters of sterilized water,[1] and this decoction placed in an incubator for three days, where a large number of bacteria developed. We used these decoctions to inoculate our sterilized percolates of sterilized and unsterilized soil in the two series of experiments, these percolates being inoculated with 1 cubic centimeter of the above culture and then incubated for twenty-four hours. The decoctions were removed from the incubator and plated, and the ordinary dilution methods followed. Cultures were made by adding ½ cubic centimeter of the dilution to agar-agar in Petri-dishes, and these were incubated for twenty-four hours, after which the colonies were counted. The agar-agar was .5 per cent.

[1] Distilled water was used in all cases in all the experiments.

normal acid in all the experiments. In the third series of experiments, where inoculation was made with Bacillus subtilis, the following method was used. A pure tube culture of Bacillus subtilis was made; from this pure culture a number of bacteria were transferred with a platinum loop to 100 cubic centimeters of sterilized water. From here on the method was followed as above indicated.

Experimental.

Table II. — *Showing Comparison of the Number of Bacteria in Decoctions of Sterilized and Unsterilized Loam. (Inoculations made with Ordinary Soil Bacteria.)*

Soil.	Number of Bacteria in 1 Cubic Centimeter of Decoction.			
	Experiment 1.	Experiment 2.	Experiment 3.	Average.
Sterilized loam,	5,680,000	3,842,000	5,218,800	4,913,600
Unsterilized loam,	276,000	402,000	391,240	343,746

The results shown in Table II. are of special interest for the following reason: in the three experiments recorded in this table the sterilized loam decoctions were found to contain a far greater number of bacteria per cubic centimeter of contents than the unsterilized loam decoction.

Table III. — *Showing Comparison between the Number of Bacteria in Decoctions of Sterilized and Unsterilized Loam and Subsoil. (Inoculations made with Ordinary Soil Bacteria.)*

Soil.	Number of Bacteria in 1 Cubic Centimeter of Decoction.		
	Experiment 1.	Experiment 2.	Average.
Sterilized loam,	5,724,000	4,693,060	5,208,530
Unsterilized loam,	203,520	199,308	201,414
Sterilized subsoil,	76,320	81,134	78,726
Unsterilized subsoil,	178,080	185,138	181,608

The results given in Table III. are important since they show that decoctions made from different soils affect the growth of bacteria in them in a decidedly different manner. When a sterilized loam is used we find a greater number of bacteria present

as compared with the number in the unsterilized loam decoction; thus the experiments with loam soil in Table III. bear out the results recorded in Table II., where the same kind of loam soil was used in the decoctions. When a sterilized and unsterilized subsoil were used in the decoctions we found that a greater number of bacteria were present in the unsterilized decoction. This fact proves that the sterilizing of this particular soil resulted in adverse conditions for bacterial increase.

At this point it might be of interest to insert a table taken from a previous report of the Hatch Experiment Station,[1] showing the growth of soy bean in sterilized and unsterilized loam and subsoil. A glance at this will show that the greatest gain in plant growth was made in the loam soil, and the least in the subsoil. These results coincide with the relative growth of bacteria in the two soils, as shown in Table III.

TABLE IV. — *Showing Growth of Soy Bean in Sterilized and Unsterilized Loam and Subsoil (from Hatch Experiment Station Annual Report, 1906).*

	Total Number of Pots used.	Average Length (Centimeters) of Stems in —		Gain or Loss in Sterilized Soil (Per Cent.).
		Unsterilized Soil.	Sterilized Soil.	
Loam, ...	4	9.53	10.87	+14.05
Subsoil, ...	4	9.79	4.14	—57.70

Glancing over this table one can readily see that there is a connection between the development of bacteria and the growth of soy beans in sterilized and unsterilized soils. The soy beans showed an increase of growth in the sterilized loam over that given in the unsterilized loam. In the subsoil the unsterilized soil produced a greater growth than the sterilized. The same held true in regard to the development of bacteria. Decoctions of the sterilized loam produced about twenty times the number of bacteria as the unsterilized. In the sterilized subsoil there is a decrease in numbers as compared with the unsterilized, or in other words, the unsterilized subsoil produced twice as many bacteria as the sterilized.

[1] Comparison of Sterilized Loam and Subsoil, by G. E. Stone, 18th Ann. Rept. of the Hatch Exp. Sta., pp. 125, 126, 1906.

That sterilization of soils produces different effects on crops according to the nature of the soil cannot be disputed. In this experiment we used two distinct types of soil, and found that sterilization affects both soils differently. In loams well supplied with organic matter the effect is a stimulation from the beginning on certain crops. In other soils, notably deficient in organic matter (like the subsoil used in this experiment), the effect may be a detrimental one.

Lyon and Bizzell [1] have shown us that steaming reduces the nitrates of the soil to nitrites and to ammonia, but most of the ammonia comes from the organic nitrogen. Russell and Hutchinson [2] claim that the increased productiveness of sterilized soils is due to an increase in the amount of ammonia present, and that the excess of ammonia is the result of the increased decomposition of soil substances by bacteria.

TABLE V. — *Showing Comparison of the Amounts of Ammonia in Decoctions of Sterilized and Unsterilized Loam. (Inoculations made with Ordinary Soil Bacteria.)*

Soil.	Amount of Ammonia in Decoction of 100 Cubic Centimeters (Grams).			
	Experiment 1.	Experiment 2.	Experiment 3.	Average.
Sterilized loam, . . .	.0051	.0052	.0051	.0051
Unsterilized loam, . .	.0032	.0031	.0030	.0030

Analysis of the soil decoctions from soils similar to those used in the experiments given in Table IV. show an increase of ammonia in the sterilized loam as compared with the unsterilized. In the subsoil we find just the reverse condition, the unsterilized subsoil containing more ammonia than the sterilized.

Analyses of the soil decoctions used in the experiments shown in Tables II. and III. give the same results as regards the ammonia content of the decoction as those enumerated above, but in our experiments (Tables II. and III.) we have sterilized decoctions of the various soils inoculated with soil bacteria. The increase and decrease in the number of bacteria found in these

[1] Effects of Steam Sterilization on the Soluble Matter in Soils, Lyttleton Lyon and J. A. Bizzell, Cornell Agr. Exp. Sta., Bul. No. 275, April, 1910.

[2] Effects of Partial Sterilization of Soil upon the Production of Plant Food, by E. J. Russell and H. B. Hutchinson, Journal of Agricultural Science, Vol. III., Part II., October, 1909.

decoctions correspond with the increase and decrease of ammonia content in each case, more ammonia being found in the decoctions which possessed the largest number of bacteria. This fact is not new, as it has been shown by Russell and Hutchinson in recent years.

TABLE VI. — *Showing Comparison between the Amounts of Ammonia in Decoctions of Sterilized and Unsterilized Loam and Subsoil.* (*Inoculations made with Ordinary Soil Bacteria.*)

Soil.	Amount of Ammonia in Decoction of 100 Cubic Centimeters (Grams).		
	Experiment 1.	Experiment 2.	Average.
Sterilized loam,	.0050	.0050	.0050
Unsterilized loam,	.0031	.0032	.0031
Sterilized subsoil,	.0020	.0021	.0020
Unsterilized subsoil,	.0030	.0032	.0031

TABLE VII. — *Showing Comparison between the Amount of Ammonia in Decoctions of Sterilized and Unsterilized Loam and Subsoils.* (*Inoculations made with Water Cultures of B. subtilis.*)

Experiment 1.

Soil.	Amount of Ammonia in Decoctions of 100 Cubic Centimeters (Grams).	Soil.	Amount of Ammonia in Decoctions of 100 Cubic Centimeters (Grams).
Sterilized loam,	.0031	Sterilized subsoil,	.0010
Unsterilized loam,	.0020	Unsterilized subsoil,	.0020

This increase in the amount of ammonia in each case is certainly brought about by the action of the bacteria upon the organic matter in the soil. Now the question arises: What change takes place within the soil, when sterilized, in order to produce this increase in the number of bacteria? In the case of the subsoil, where the increase takes place in the unsterilized soil, it is a question as to what change takes place upon sterilizing that has a detrimental effect on bacteria.

Russell and Hutchinson [1] tried the effect of untreated soil

[1] The Effects of Partial Sterilization of Soil on the Production of Plant Food, by E. J. Russell and H. B. Hutchinson, Journal of Agricultural Science, Vol. III., Part II., October, 1909, p. 117.

upon sterilized soil and found a decrease in the number of bacteria and in the amount of ammonia present. This would show that there is some limiting factor in the original soil that limits bacterial action. They claim that this limiting factor is not chemical but biological.

In the experiments which we have described and in those which follow we are unable to comprehend how protozoan forms play any rôle whatsoever in the decrease of bacteria. If this is true this limiting factor must be a chemical or physical property of the soil, and one on which sterilization has a marked effect.

Protozoa as a Factor in the Bacterial Flora of Soils.

The remaining contents of the soil culture used in inoculating decoctions in the experiments of Tables II. and III. were subjected to a careful microscopic examination for various forms of protozoa. Our labors were without results, however, no protozoa being found; but it is quite possible that a few might have been introduced at the time of inoculation of the decoctions. To avoid any possibility of introducing protozoa into decoctions the experiments shown in Table VIII. were made.

Table VIII. — *Showing Comparison of Number of Bacteria in Decoctions of Sterilized and Unsterilized Loam and Subsoils. (Inoculations made with Water Culture of B. subtilis.)*

Soil.	Number of Bacteria in 1 Cubic Centimeter of Decoction.		
	Experiment 1.	Experiment 2.	Average.
Sterilized loam,	5,952,960	4,913,800	5,423,300
Unsterilized loam,	127,484	111,964	117,324
Sterilized subsoil,	279,840	283,380	281,610
Unsterilized subsoil,	2,060,640	2,901,244	2,480,942

The data given in the above table show that Bacillus subtilis multiply in great numbers in all the decoctions. About the same relative number of bacteria were found here as in the decoctions shown in the experiments given in Tables II. and III. A greater number of Bacillus subtilis were found in the sterilized loam decoctions as compared with the unsterilized; also a greater

number of Bacillus subtilis were found in the unsterilized subsoil decoctions as compared with the sterilized decoctions.

A careful consideration of our work leads us to believe that protozoa were absent in all our decoctions, and the experiments shown in Table VIII. seem to substantiate this belief; moreover, protozoa were uncommon in the soils used. A number of samples of the loam and subsoil were subjected to examination, but very few protozoan forms [1] were found. In this vicinity great numbers of protozoa are found in pools of standing water, while few are observed in garden soils. In other localities protozoa may be more abundant in soil; however, no data are available. For protozoa to reduce the bacterial flora of the soil to an appreciable degree by devouring the bacteria, it is certain that the number of protozoa present in the soils of Amherst would have to be increased manyfold; besides, all protozoa do not consume bacteria. G. N. Calkins, professor of protozoölogy at Columbia University of New York, is the authority for the following: "All classes of protozoa except Sporozoa are bacteria eaters except the carnivorous forms." The same authority in a recent work [2] says: "Two of the most striking phenomena among the protozoa are the apparent choice of food and the selection of certain materials for building shell." The author notes that certain protozoa will live almost exclusively on other protozoa and such vegetable forms as Oscillaria, Spirogyra and diatoms. "Each protozoan will eat only its favorite food, although other food is abundant." If the above is true it means that hundreds of protozoan forms of the soil do not feed on bacteria, therefore it is impossible to credit the difference in the numbers of bacteria in a gram of soil [3] — 7,000,000, and a gram of treated soil (sterilized) 37,000,000 — to the elimination of the protozoa. This remarkable increase in the number of bacteria of over fivefold of the original number in the untreated soil can only be explained by an increased food supply. In our experiments with soil decoctions, where the protozoa were entirely eliminated, we obtained a difference in numbers of bacteria present in the decoctions of sterilized and unsterilized soils ranging from fifteen to twenty

[1] The following species were observed: Halteria, Enchelys, Paramœcum, Amœba, Euglena, Euplotes, Dileptus, Strombidium and Oxytridia.

[2] The Protozoa, Columbia Biol. Ser., VI., p. 305.

[3] Hall, Harper's Magazine, October, 1910, p. 681.

times as many in the sterilized as compared with the unsterilized decoctions. However, in the experiments where sterilized and unsterilized subsoil were used we found more bacteria in the unsterilized decoctions as compared with the sterilized decoctions. This fact proves that sterilization does not in every case result in an increased number of bacteria in the soil thus treated.

Conclusions.

1. The development of bacteria may be retarded or accelerated in soil decoctions by the use of sterilization.

2. In decoctions of soil rich in organic matter the development of bacteria is greatly increased, while in soils deficient in organic matter the development of these organisms is retarded by sterilization.

3. The stimulating or retarding effects on the development of bacteria of the two types of sterilized soil used by us are similar to those produced upon the growth of crops in these soils. (*Cf.* Table IV.)

4. From numerous microscopic examinations made of Amherst soils we do not find that protozoa are abundant; neither were they observable in our soil decoctions.

5. The question of protozoa as a biological factor was eliminated in the experiments. The stimulating or retarding effect on the development of bacteria was due to other causes.

6. Our experiments therefore, made with Amherst soils, do not confirm those of Russell and Hutchinson, who maintain that protozoa influence the number of bacteria in soils, since the development of bacteria differs in soil decoctions according to the composition of the soil used; that is, the number of bacteria which develop in a soil depends upon the chemical and physical condition of the soil rather than upon the number of protozoa.

7. These experiments do not necessarily preclude the idea that protozoa might play a much more important rôle in soils other than those with which we experimented.

THE EFFECTS OF POSITIVE AND NEGATIVE ELECTRICAL CHARGES ON SEEDS AND SEEDLINGS.

G. E. STONE.

Considerable interest is now being manifested in the effects of electricity on plant growth, and experiments are being made in this country and abroad to study this influence. Most of the experimenters at the present day are making use of high tension wires, the aim being to charge the atmosphere rather than the soil.

For many years we have been carrying on experiments along this line, and many of the results have been published from time to time.[1] However, we still have considerable data on the various phases of the subject of electrical stimulation which have not been published, as in many cases the experiments have not been completed.

The experiments given here were made under my direction in 1904 by Mr. N. F. Monahan, a former assistant in the laboratory, who while with us paid quite a little attention to the subject of electrical stimulation and plant reaction. They were made to determine the relative stimulating effect of positive and negative charges on seed germination and growth of seedlings. The seeds of lettuce and radish which we used were first moistened by soaking in water for a few hours and were then charged from a small friction machine, Töpler-Holtz model. They were then placed in electro-germinators, which consisted of a modified Leyden jar and Zurich germinator, and 10 small sparks from a Töpler-Holtz machine were applied to each germinator, which

[1] Electro-Germination, Hatch Exp. Sta., Bul. No. 43, 1897; The Influence of Current Electricity upon Plant Growth, Hatch Exp. Sta., 16th Ann. Rept., 1904; The Influence of Atmospheric Potential on Plants, Hatch Exp. Sta., 16th Ann. Rept., 1904; The Influence of Electrical Potential on the Growth of Plants, Hatch Exp. Sta., 17th Ann. Rept., 1905; Comparisons of Electrical Potential in Trees and in the Free Air, Hatch Exp. Sta., 17th Ann. Rept., 1905; Injuries to Shade Trees from Electricity, Hatch Exp. Sta., Bul. No. 91, 1903; Influence of Electricity on Micro-organisms, Bot. Gazette, 48; No. 5, November, 1909; Effects of Electricity on Plants, Bailey's Cyclopedia of American Agriculture, Vol. II., p. 30.

resulted in stimulation of the seed. The germinator was then placed in an autoclave and kept at a temperature of about 25° C. The results of the experiments follow: —

TABLE I. — *Showing the Results of the Stimulating Effect of Positive and Negative Electrical Charges on Radish Seeds and Seedlings (Raphanus sativus, L.).*

[Average of two experiments in each of which 60 seeds were used. Moist treated seed charged with 10 small sparks from a Töpler-Holtz machine. Measurements in millimeters, temperature 25° C.]

Treatment.	Average Length of —		Per Cent. gained in Length of —	
	Hypocotyl (Centimeters).	Radicle (Centimeters).	Hypocotyl.	Radicle.
Normal,	1.13	1.07	–	–
Negative charge,	1.39	1.24	23.00	15.88
Positive charge,	1.72	1.76	52.21	64.48

It is quite evident that the electrical treatment stimulated the seed very materially, as shown by the growth of the hypocotyls and radicles given in this table. The average increased length of the radicles and hypocotyls of the negatively charged seeds over that of the normal was 23 per cent. for the hypocotyl and 15.88 per cent. for the radicle. The positively charged seeds gave an average increase of 52.21 per cent. for the hypocotyl and 64.48 per cent. for the radicle over that of the normal; showing that the positive charges induced the greater growth. No attention was given to accelerated germination in this experiment.

TABLE II. — *Showing the Results of the Stimulating Effect of Positive and Negative Electrical Charges on Lettuce Seeds and Seedlings (Lactuca sativa, L.).*

[Average of two experiments in each of which 60 seeds were used. Moist treated seed charged with 10 small sparks from a Töpler-Holtz machine. Measurements in millimeters, temperature 25° C.]

Treatment.	Average Length of —		Per Cent. gained in Length of —	
	Hypocotyl (Centimeters).	Radicle (Centimeters).	Hypocotyl.	Radicle.
Normal,	0.96	1.52	–	–
Negative charge,	1.08	1.77	12.50	16.40
Positive charge,	1.21	2.18	26.00	43.42

In the experiments shown in Table II. the accelerated growth of the hypocotyl and radicle is somewhat similar to that shown in Table I., namely, the negative charges gave for the hypocotyl 12.5 per cent. increase, for the radicle 16.4 per cent., while the positively charged seeds gave 26 per cent. for the hypocotyl and 43.42 per cent. for the radicle. Here, too, the positively charged seeds gave the largest average increased growth for both hypocotyl and radicle.

The experiments shown in Tables I. and II. are typical of others made along the same line, although we have repeatedly found that it is quite an easy matter to charge the seed too strongly and obtain retardation in growth. Instead of using ten-minute sparks to stimulate the seeds in the electro-germinator we have found by subsequent experiments that it is better to use only two or three, and these should be very slight charges. The stimulating effect of positive and negative charges on germination is similar to that on growth, but there is no evidence to show that the treatment affects the germinating capacity of seeds, and we have stimulated many thousands. The following table gives an average of four experiments with seed germination.

TABLE III. — *Showing Results of the Stimulating Effects of Positive and Negative Electrical Charges on Germination of Lettuce Seed* (*Lactuca sativa, L.*).

[Average of four experiments, 20 seeds being used in each treatment; otherwise the same experiments as shown in Tables I. and II.]

Treatment.	Total Number of Seeds.	Number of Seeds germinated in — 24 Hours.	48 Hours.	72 Hours.
Normal,	80	19	35	64
Negative charge,	80	24	51	64
Positive charge,	80	48	69	72

From the experiments in Table III. it will be observed that germination is accelerated to a considerable degree by electrical stimulation, and that the positive caused greater acceleration than the negative charges, corresponding to the effects produced on the growth of the hypocotyl and radicle. In Fig. 1 is shown a diagrammatic representation of seedlings based upon an aver-

age of all the data given in Tables I. and II. It will be noticed that the radicles are stimulated more in all cases than the hypocotyls, this difference being more pronounced in the positively than in the negatively charged seedlings. In Fig. 2 are shown

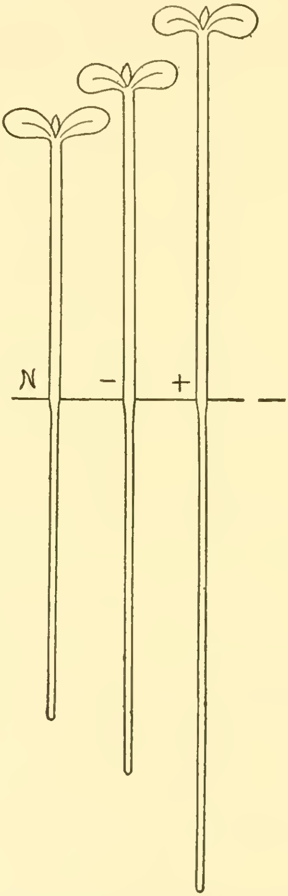

Fig. 1.—Showing the effects of positive and negative electrical charges on the growth of lettuce and radish seedlings. Average of the results in Tables I. and II.

the effects of positive and negative charges on the growth of radish seedlings, being an average of two experiments. Fig. 3 shows the effects of positive and negative electrical charges on the growth of lettuce seedlings, being an average of three experiments.

It is not surprising that the radicles show greater development than the hypocotyls since the former develop first, and for this reason electrical stimulation would show itself more prominently in the radicle than the hypocotyl. Accelerated germination is

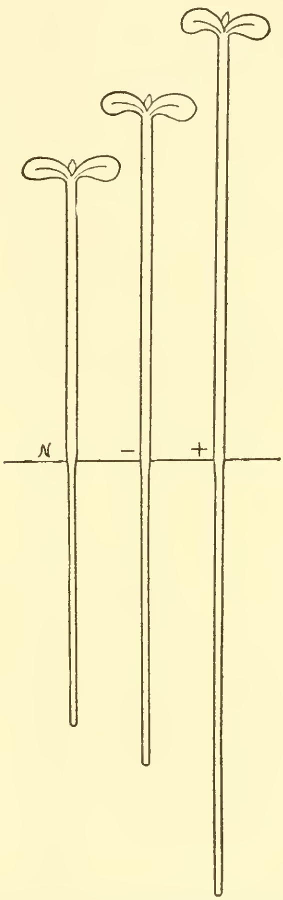

FIG. 2. — Showing the effects of positive and negative electrical charges on the growth of radish seedlings. Average of two experiments.

shown more prominently in the positively than the negatively charged seeds. The positive charges stimulated both the hypocotyl and radicle more than the negative charges, and if the difference in the time of the development of the hypocotyl and radicle is taken into consideration it will be seen that there is

little or no difference in the effects of the stimulation on the radicle and hypocotyl.

The effects of a series of charges from a static machine last only two or three days, the maximum effect of the stimulus showing itself shortly after stimulating.

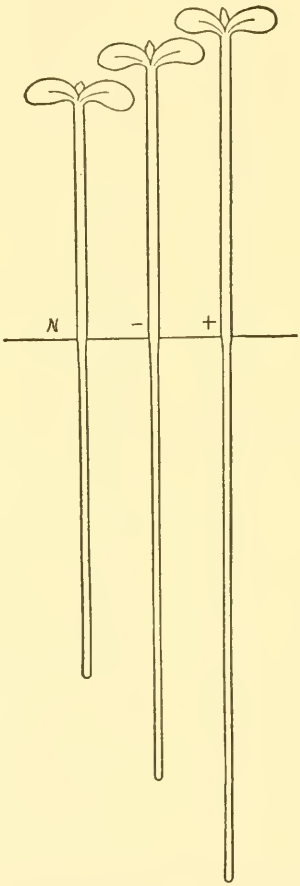

FIG. 3. — Showing the effects of positive and negative electrical charges on the growth of lettuce seedlings. Average of three experiments.

The roots and stems of plants react positively and negatively to various stimuli such as are afforded by gravity, light, moisture, chemical substances, etc. It is also well known that the same stimuli will induce reactions of an exactly opposite character in the same organism, or even in the same organ. Usually,

however, the stem reacts one way and the root another; for example, roots are positively and stems negatively geotropic. It is well known that the anode and cathode behave quite differently and characteristically when acting on metals, etc. Similar characteristic differences might be expected in the reaction of plants. Where trees have been injured by burning from direct current wires the extent of the injury is about 90 per cent. greater near the positive than near the negative point of contact, showing that the positive electrode is more disastrous to plant tissue.

In our various experiments, where we have employed electricity as a stimulus, we have never observed any difference in the behavior of plants in close proximity to either positive or negative electrodes, although in some of our previous experiments with radish plants, made some years ago, in which the plants were grown in soil, we found that the tops responded much more freely to electrical stimulation than the roots when acted on by galvanic currents. We found, however, that by substituting lettuce, which is cultivated exclusively for the leaves, the leafy part responded more freely to electrical stimulation than did the underground part or fleshy roots of radish.

On the other hand we found in our experiments in growing radishes in tightly closed, insulated glass cases, the atmosphere of which was charged each day positively to an electrical potential averaging 150 volts, that the reverse was true, viz., the roots or underground parts were stimulated more than the leaves or tops. The soil itself is generally negative, and the atmosphere positive; the roots therefore are accustomed to a negatively charged, and the aerial parts to a positively charged, environment.

In the decomposition of water by electrolysis it is assumed that the oxygen is in a negatively electrical condition and is attracted by the positive pole, while the hydrogen is in a positively electrical condition and is attracted by the negative pole. Metals are described as electro-positive elements, and are usually attracted to the negative pole, while the nonmetals are spoken of as electro-negative elements and are attracted to the positive pole. In the experiments just cited with radishes, which were grown in insulated glass cases where the atmosphere was charged posi-

tively, the leaves were stimulated least and the roots most; that is, the roots, which are normal to an environment negatively charged, were stimulated most by the positive charges. In the case of galvanic stimulation of roots it is known that weak currents induce negative bendings; that is, towards the cathode, while strong currents induce positive bendings, or towards the anode. In the negative reactions, which are induced by weak currents, there is a greater growth on the side of the root towards the positive pole or anode than towards the negative pole or cathode, but there is some doubt as to whether the reverse holds true for positive galvanotropic bendings. In the case of positive galvanotropic bendings Brunchorst has pointed out that the reaction is the result of pathological conditions, and it is maintained that bendings towards the anode are due to injury of the delicate root tip by the strong currents employed. This interpretation of the phenomena appears to harmonize with the results which we have obtained with positive and negative electrical charges on plants. The positive charges give the greatest and the negative the least accelerated growth. Since the positive charges stimulate mostly those cells on the surface of the root nearest to the anode, those cells would grow more rapidly and the normal downward direction of the root would be directed towards the negative pole or cathode. The burning effect on trees from positive and negative electrodes is similar, the positive producing the greater injury, and this coincides with our results obtained by using strong positive static charges on plants, viz., strong positive static charges cause a greater degree of retardation and injury than negative charges. The use of strong positive currents would result in the cells on the anode side of the root being retarded, hence bendings towards the anode would result.

To summarize we might state that the effect of positive and negative stimulation on plants offers a mechanical explanation of the positive and negative galvanotropism in roots. When plants are grown between positive and negative electrodes, each electrode exerts a characteristic influence on the root, and that surface of the root nearest to the anode will be affected according to the nature of the stimulus on that side; and conversely, that part of the root adjacent to the cathode will be affected accord-

ing to the nature of the stimulus characteristic of that pole. When weak currents are employed the positive current or anode gives the greatest stimulation to those cells on the anode side of the root, and induces bendings in the root towards the negative pole or cathode. On the other hand, when strong currents are employed the positive current induces bendings towards the anode due to a retardation or injury to the cells on the side of the root towards the anode.

From our various experiments in electrical stimulation we are of the opinion that increasing the electrical tension or potential of the atmosphere, either by the use of static charges or from high tension wires, gives rise to a greater degree of stimulation than passing the current through the soil. Alternating currents appear to be superior to direct currents in stimulating plants. There is, however, the question of increasing the number of micro-organisms in the soil by electrical stimulation as well as the importance of nitrification and nitrogen fixation resulting from electrical stimulation, a line of research on which we are now engaged and on which we hope to report later.

ELECTRICAL RESISTANCE OF TREES.

G. E. STONE AND G. H. CHAPMAN.

It has long been known that trees offer considerable resistance to electric currents, but at the time our experiments were undertaken we were not aware that much attention had been given to this subject, especially regarding the influence of certain factors on resistance. The effect of lightning strokes indicates that trees possess relatively high resistances, and that there is a difference in the resistance of their various tissues. Little or no data appear to be available concerning this subject, nor so far as we know concerning the resistance of different trees at different seasons of the year.

In a former publication [1] we have given the results of some observations on the electrical resistance of trees, and the numerous data which we obtained by passing electrical currents through trees and various plants helped to give us some idea of their electrical resistance. Our object in carrying on these experiments was to determine whether there were any variations in the electrical resistance of different sides of a tree trunk as regards points of the compass. Originally it was our purpose to learn whether the electrical resistance varied greatly from month to month during the year, and if so, what causes led to this variation; in fact, to study the effects of various influences on electrical resistance. But the temporary suspension of our work, made necessary by moving from one laboratory to another, and the change of assistants interrupted our plans somewhat, and the original idea of our investigation was not followed.

It might be supposed that since the several sides of a tree are exposed differently to light and heat they would show slight

[1] Injuries to Shade Trees from Electricity, by G. E. Stone, Mass. Agr. Exp. Sta., Bul. No. 91. 1903.

variations in temperature, and that there would also be differences in the flow of sap and the translocation of plastic substances. That this is true is shown by the fact that trees make more growth on one side than on another, the more or less localized photosynthesis causing a greater transmission of plastic substances on that side.

Some of these experiments were begun in 1907, a part of the observations being made by Mr. N. F. Monahan, our former assistant, while others were obtained in 1909 and later by Mr. G. H. Chapman.

These resistances were determined by a Weston Electric Company combination bridge, rheostat and galvanometer, provided with a battery of 6 or 8 large Samson cells.

TABLE I. — *Showing Daily Records of Electrical Resistance (in Ohms) of Maple (Acer saccharum, Marsh), April 7–26, 1907. Resistances taken on the North, South, East and West Sides of the Tree at Midday.*

[Electrodes 10 feet apart. Mean daily temperatures given in degrees F.]

Date.	Temperature.	East.	South.	West.	North.
April 7,	35	19,000	18,840	22,000	22,000
8,	33	19,500	19,000	23,400	23,000
9,	31	23,000	23,000	23,000	24,000
10,	35	23,000	23,000	23,000	23,500
11,	39	22,000	21,500	23,000	23,500
12,	38	21,000	21,000	22,500	23,000
13,	37	21,500	21,000	22,900	23,000
14,	42	20,000	19,400	22,000	22,000
15,	39	19,100	18,900	21,200	20,800
16,	40	19,500	19,000	20,000	21,500
17,	40	20,500	20,500	21,500	21,000
18,	39	21,500	23,000	21,000	17,000
19,	34	21,000	20,000	19,000	21,000
20,	37	18,000	18,300	21,300	20,800
21,	36	19,500	19,500	22,000	21,000
23,	52	15,000	14,600	16,300	16,000
24,	49	16,000	17,300	17,000	16,500
25,	52	16,900	17,200	17,400	19,100
26,	56	15,700	15,000	16,000	18,200
Average,	–	19,857	19,055	19,310	20,890

TABLE II. — *Showing Daily Records of Electrical Resistance (in Ohms) of Elm (Ulmus Americana, L.), April 7–26, 1907. Resistances taken on the North, South, East and West Sides of the Tree at Midday.*

[Electrodes 10 feet apart. Mean daily temperatures given in degrees F.]

DATE.	Temperature.	East.	South.	West.	North.
April 6,	35	29,000	29,000	29,500	29,000
7,	35	28,200	28,000	29,000	29,400
8,	33	29,000	28,500	29,500	29,500
14,	42	25,000	25,000	26,500	23,000
15,	39	25,500	26,500	26,000	26,000
16,	40	26,000	23,500	26,500	27,000
17,	40	26,000	29,000	25,000	23,000
18,	39	25,000	30,000	27,000	25,000
19,	34	25,600	32,000	24,900	24,200
20,	37	25,000	29,000	27,800	24,000
21,	36	25,000	29,900	28,000	25,000
23,	52	23,200	26,200	22,500	21,000[1]
24,	49	19,600	26,000	22,100	18,000
25,	52	22,000	26,000	23,000	20,000
26,	56	19,000	21,400	19,300	19,700
Average,	–	24,666	27,466	25,777	25,253

The data shown in Tables I. and II. give the electrical resistance of a maple and elm tree covering a period of nearly one month in the spring, when there was an occasional flow of sap. The elm was a large tree, over 2 feet in diameter, and the maple was nearly as large. In both cases the electrodes, which were about 3 inches long and made of galvanized iron nails, were driven through the bark and into the wood. These were connected by solder with insulated copper wires leading to a combination bridge, from which the readings were made. The batteries consisted of half a dozen cells employed to take the readings. In these experiments the electrodes were 10 feet apart on the north, south, east and west sides of the trees. The lowest electrodes were placed about 2 feet above the ground, and the highest about 12 feet.

[1] Warm.

By comparing the results given in these tables it will be seen that the resistances obtained from the north, south, east and west sides of the tree showed some variation from day to day, and also on different sides of the tree. In the maple a slightly higher average resistance was shown on the north side of the tree than on any other side, followed by the east, west and south sides.

In the case of the elm (Table II.), however, the highest average resistance was shown on the south side for the same period, this being followed by the west side, while the east side showed the least resistance. The resistance in both cases showed a tendency to decrease towards the latter part of April, when the temperature increased, as is shown by a comparison of the mean daily minimum and maximum temperature records which were taken from the station's meteorological observatory located nearby, and which are given in both tables. The highest average resistance for the maple was given on the 9th of April, when there was the lowest mean temperature. The highest average resistance given by the elm occurred on April 6 and April 8 (the records were not taken on the 9th), while the lowest average resistance for the maple occurred April 23, during one of the highest mean temperature days. The lowest average resistance for the elm occurred April 26, which date gave the highest mean temperature.

Table III. — *Showing Electrical Resistance (in Ohms) of Maple (Acer saccharum, Marsh), covering a Period of Nearly Three Months. Resistances taken on the North, South, East and West Sides of the Tree about Midday.*

[Electrodes 10 feet apart. Mean daily temperatures given in degrees F.]

Date.	Temperature.	East.	South.	West.	North.
April 7,	35	19,000	18,840	22,000	22,000
14,	42	20,000	19,400	22,000	22,000
21,	36	19,500	19,500	22,000	21,000
26,	56	15,700	15,000	16,000	18,200
Average for month,	–	18,550	18,185	20,500	20,800

Table III. — *Concluded.*

Date.	Temperature.	East.	South.	West.	North.
May 8,	58	18,500	21,000	19,000	23,000
14,	68	14,000	14,600	15,000	16,000
21,	46	24,000	23,600	23,000	33,000
28,	45	27,800	23,000	29,600	26,000
Average for month,	–	21,075	20,550	21,650	24,500
June 4,	55	18,600	19,100	23,600	21,700
12,	59	21,000	22,000	23,900	23,000
Average for month,	–	19,800	20,550	23,750	22,350
Average for three months,	–	19,775	19,761	21,883	22,550

Table IV. — *Showing Electrical Resistance (in Ohms) of Elm (Ulmus Americana, L.), made Weekly and covering a Period of Nearly Three Months. Resistances taken on the North, South, East and West Sides of the Tree.*

[Electrodes 10 feet apart. Mean daily temperatures given in degrees F.]

Date.	Temperature.	East.	South.	West.	North.
April 7,	35	28,200	28,000	29,000	29,400
14,	42	25,000	25,000	26,500	23,000
21,	36	25,000	29,900	28,000	25,000
26,	56	19,000	21,400	19,300	19,700
Average for month,	–	24,300	26,075	25,700	24,275
May 8,	58	17,200	18,000	16,400	19,000
14,	68	10,800	11,200	11,000	12,600
21,	46	13,000	16,300	16,000	18,900
28,	45	11,100	17,500	15,900	19,000
Average for month,	–	13,025	15,750	14,825	17,375
June 4,	55	9,000	13,000	12,000	12,300
12,	59	6,300	15,000	12,000	11,700
Average for month,	–	7,650	14,000	12,000	12,000
Average for three months,	–	14,992	18,608	17,508	17,883

The data in Tables III. and IV. cover weekly observations extending over a part of three different months, the same trees

being used as in the preceding experiments. The results shown in these tables present similar features to those in the preceding ones.

The lowest average resistance during any single day for the maple occurred May 14, when the temperature was highest, while the highest average resistance was on May 28, when the temperature was low, but not the lowest. The average resistance for the different sides of the tree for the whole period was the highest on the north side, followed by the west, east and south sides. For the elm the lowest average resistance for a single day was shown on May 14 and June 12, days when the temperature was highest. The highest average resistance shown corresponds to the lowest temperature, which was recorded on April 7. The average resistance for the different sides of the elm during the whole period was the highest on the south, followed by the north, west and east sides.

The experiments shown in Table V. were supervised by Mr. Chapman during the spring of 1909. The resistances were obtained from a large maple tree located near our laboratory which was a different specimen from the one used in the preceding experiments. The tree was a typical rock maple of this region, in fairly vigorous condition, slightly over 2 feet in diameter at the base. The resistance readings were obtained from a combination bridge, as in previous experiments, and a battery of 8 Samson cells was used. The electrodes consisted of galvanized iron nails about 3 inches long, which were driven through the bark into the wood for about 1½ inches. The part of the electrodes extending beyond the surface of the wood was enclosed within porcelain insulators. Before the electrodes were inserted into the tree at the various points a part of the bark extending to the wood was removed with a chisel for a space of 2 inches. The electrodes were 8 feet apart in each case, the lower ones being placed about 2½ feet from the ground, and the highest about 10½ feet, hence the resistances were taken from that part of the tree between 2½ and 10½ feet of the trunk. The wires, 8 in all, were connected with the electrodes by means of solder and were run into the laboratory about 50 feet away, all the readings being taken under cover. The resistances were read three times each day, viz., at 8 A.M., 12 M. and 4 P.M. from March 18 to March 30, inclusive.

TABLE V. — *Showing Daily Records of Electrical Resistance (in Ohms) of Maple (Acer saccharum, Marsh), March 18–31, 1909. Resistances taken Three Times Daily on the North, South, East and West Sides of the Tree.*

[Electrodes 8 feet apart.]

DATE.	8 A.M.				12 M.				4 P.M.			
	North.	West.	South.	East.	North.	West.	South.	East.	North.	West.	South.	East.
March 18,	138,500	147,500	157,700	136,300	79,980	82,670	105,900	33,980	73,100	84,540	93,200	74,200
19,	56,460	63,500	76,500	62,000	37,900	38,760	44,140	36,470	35,900	34,100	36,500	35,600
20,	121,000	126,400	86,870	68,850	99,700	85,400	62,000	68,200	77,988	54,360	46,530	62,120
21,	182,000	170,000	86,200	58,180	78,500	53,100	42,000	35,900	43,100	30,000	32,750	33,800
22,	52,100	45,800	45,700	38,360	38,640	33,650	34,750	31,100	34,350	30,000	31,050	29,950
23,	32,100	32,100	31,680	28,990	28,890	28,870	28,600	26,980	29,910	29,800	30,000	27,950
24,	31,580	30,000	30,070	25,850	26,680	26,250	26,500	23,990	33,800	22,050	23,700	22,800
25,	69,860	73,700	58,960	52,870	66,400	49,980	37,650	35,600	37,100	26,000	32,100	31,000
26,	38,700	38,600	50,100	40,000	30,390	30,320	37,000	30,200	29,110	29,100	33,100	25,000
27,	29,100	32,080	37,000	26,400	23,100	27,500	29,600	23,000	28,000	29,760	32,100	27,900
28,	40,100	46,300	48,400	38,500	40,000	44,000	47,050	37,500	29,910	31,000	39,100	29,000
29,	37,000	–	38,500	34,700	35,400	–	37,750	29,400	32,000	–	31,400	28,700
30,	51,000	56,000	60,000	41,000	39,000	43,050	47,000	36,050	38,000	38,000	47,000	38,000
Averages,	67,654	71,832	62,130	50,155	48,044	45,300	44,610	37,567	40,174	36,560	39,580	35,847

TABLE VI. — *Showing Temperature Conditions, etc., during the Month of March.*

Date.	8 A.M.			12 M.			4 P.M.		
	Weather.	Sap.	Temperature.	Weather.	Sap.	Temperature.	Weather.	Sap.	Temperature.
March 18,	Overcast, cool, no wind.	No flow.	37.0	Overcast, snow, no wind, cold.	No flow.	35.0	Overcast, sleet, no wind, cold.	No flow.	30.0
19,	Overcast, cool, no wind.	No flow.	34.0	Fair, cold, no wind.	No flow.	39.0	Fair, sunshine, windy, cold.	No flow.	35.5
20,	Fair, sun, wind.	No flow.	41.0	Fair, cool, no wind.	No flow.	37.5	Overcast, cold, no wind.	No flow.	32.0
21,	Clear, sun, slight wind.	Slow flow.	36.5	Clear, sunshine, no wind.	Flow.	46.5	Fair, cool, no wind.	No flow.	35.5
22,	Clear, sun, wind west.	Flow.	46.5	Clear, sunshine, wind west.	Flow.	48.5	Clear, cool, wind west.	Flow.	45.5
23,	Clear, sun, wind southwest.	Great flow.	45.5	Overcast, warm, no wind.	Great flow.	53.5	Overcast, rain, no wind.	Flow.	47.0
24,	Clear, sun, wind southwest.	Great flow.	50.0	Fair, sun, wind southwest.	Great flow.	55.5	Fair, warm, wind southwest.	Flow.	52.0
25,	Clear, sun, wind.	No flow.	35.0	Clear, sun, wind.	Flow.	35.5	Clear, cool, wind.	Great flow.	35.0
26,	Overcast, cold, windy.	Slow flow.	41 0	Clear, cold, high wind.	Flow.	53.5	Fair, cool, wind.	Great flow.	58.0
27,	Cloudy, warm, no wind.	Slow flow.	53.0	Fair, warm, no wind.	Flow.	64.5	Fair, warm, no wind.	Flow.	54.5
28,	Cloudy, warm, no wind.	No flow.	44.0	Rain, cool, no wind.	Flow.	46.5	Clear, warm, wind.	Flow.	61.0
29,	Rain, cool, no wind.	No flow.	47.5	Rain, cool, no wind.	No flow.	48.5	Rain, cool, no wind.	Flow.	46.5
30,	Clear, cool, moderate wind.	Flow.	42.0	Clear, cool, moderate wind.	Flow.	45.0	Clear, cool, moderate wind.	Flow.	44.0

The resistances in Table V. were taken in March and represent considerably higher readings than those given in the preceding tables, although there the distance between the electrodes was 10 feet, while in the readings shown in Table V. the distance was only 8 feet. The higher resistance is due, as shown in this table, to the cutting away of some of the outer tissue around the electrodes, a feature which will be discussed later; and also in part to the measuring of the resistances in March instead of in April, May and June, as was the case with the preceding observations.

The results obtained from these readings, however, are somewhat similar to those given in the preceding tables; the highest resistance occurring on cold days and the lowest on warm days. The highest resistance shown in any one observation was on March 21, at 8 A.M., on the north side of the tree. The temperature for this same period was 36.5° F., which is one of the lowest recorded. The lowest resistance was on the 24th of March, at 4 P.M., on the east side of the tree following one of the high temperature periods. The highest average resistance for any single day occurred March 18, and this coincides with the lowest average temperature. The lowest average resistance for any single day occurred March 24, followed by March 27, which were the two warmest days. The average temperature records for both days, taken at the time of the observation, was as follows: March 24, 52.5° F., the average temperature for the 27th being 57.3° F. The mean temperature (maximum and minimum) on this date was 38, and that for March 27 was 41. By referring to Table VI. it will be observed that March 24 was clear and sunshiny, with the wind southwest, and March 25 was fair and warm, and occasionally cloudy, with no wind. The average resistance for all periods was the greatest in the morning, followed by those given at 12 M. and 4 P.M. At 8 A.M. it was 62,942, at 12 M., 43,880, and at 4 P.M., 38,040 ohms.

Table VII. — *Showing Maximum and Minimum Resistances based on the Averages obtained from the North, South, East and West Sides of Maple Tree (Acer saccharum, Marsh) for Different Periods during the Day, March 18–31, 1909.*

8 a.m.	West, highest,	71,832
	North,	67,654
	South,	62,130
	East, least,	50,155
12 m.	North, highest,	48,044
	West,	45,300
	South,	44,610
	East, least,	37,567
4 p.m.	North, highest,	40,174
	South,	39,580
	West,	36,560
	East, least,	35,847

This table is adapted from Table V. It will be noticed that the highest average resistance was obtained on the west side for the 8 a.m. observations, and the north side gave the highest average resistance for the two following observation periods, viz., at 12 m. and 4 p.m. The lowest average resistance from March 18 to 31 occurred on the east side for each of the three periods. The average daily resistance for the whole period — 9 a.m. to 4 p.m. — was as follows: north side, 51,957; west side, 51,230; south side, 48,773 and east side, 41,189. These results coincide with those given in the preceding tables, that is, the north side shows in general the highest resistance.

Table VIII. — *Showing Electrical Resistance (in Ohms) of Maple (Acer saccharum, Marsh) from March 18–31, 1909. Resistances taken at 8 a.m., 12 m. and 4 p.m. on the South Side of the Tree.*

[Electrodes 8 feet apart. Temperature same as in Table VI.]

Date.	8 a.m.	12 m.	4 p.m.
March 18,	46,890	27,700	27,200
19,	23,350	20,400	20,900
20,	42,320	26,830	23,840
21,	53,900	22,510	19,300
22,	25,800	19,820	18,300
23,	18,790	16,700	16,500
24,	18,000	17,150	16,540
25,	39,690	21,000	15,600
26,	23,300	17,200	14,900
27,	18,300	15,700	15,100
28,	25,400	23,600	14,950
29,	20,200	16,800	16,000
30,	29,000	20,600	19,000
Averages,	29,610	20,462	18,318

The resistances given on the south side of the same maple tree as in Table V. are given here; in this case, however, the electrodes were attached differently, being driven through the bark into the wood, and none of the tissue around them was cut away.

The resistances given here run considerably lower than those shown in Table V. for the same tree for the same period, due to the fact that the electrodes were inserted differently into the tree. If we compare the average resistances obtained from the two experiments, those in Table VIII. and those in Table V., we obtain the following for the same period, with the same tree. The average resistances on the south side of the tree shown in Table V. are as follows for the three different periods: 8 A.M., 62,130; 12 M., 44,610; 4 P.M., 39,580, while those given in Table VIII. are 29,610, 20,462 and 18,318 ohms.

The higher resistance shown in Table V. represents not only that of the cambium, but of some of the wood as well.

The highest resistance readings were obtained at 8 A.M., while the lowest were obtained at 4 P.M. The midday temperatures were highest, as might be expected, with little difference in the morning and afternoon.

The after effects of the higher temperatures influenced the resistances taken at 4 P.M., since the tree, being generally exposed to the sun's rays for a considerable period in the day, would become warmer, and the heat would be retained for some time. It was thought desirable to make one experiment when the observations could be recorded hourly. The results of these observations are shown in Table IX.

TABLE IX. — *Showing Record of Electrical Resistance (in Ohms) of Maple (Acer saccharum, Marsh) for One Day, the Records being taken hourly, April 27, 1907.*

[Electrodes 10 feet apart.]

TIME.	East.	South.	West.	North.	Weather.	Remarks.	Temperature (Degrees F.).
6.15 A.M.,	24,700	23,100	22,400	26,000	Wind, cold.	Sap not started.	39
7.15 A.M.,	24,600	23,100	22,300	25,900	Wind, cold.	Sap not started.	40
8.15 A.M.,	24,600	23,000	22,200	26,000	Wind, cool.	Sap just started.	44
9.15 A.M.,	24,500	20,200	21,000	25,400	Wind, cool.	Sap flowing more freely.	48
10.15 A.M.,	23,500	18,600	19,000	24,700	Light wind, warm.	– – –	52
11.15 A.M.,	22,100	19,500	18,100	23,600	Light wind, warm.	– – –	55
12.15 P.M.,	21,200	18,800	17,700	22,500	Light wind, warm.	– – –	58
1.15 P.M.,	20,000	17,300	16,800	22,200	Calm, warm.	– – –	59
2.15 P.M.,	18,800	17,000	16,600	21,800	Calm, warm.	– – –	59
3.15 P.M.,	19,300	18,300	16,800	22,500	Calm, warm.	Sap flowing less freely.	60
4.15 P.M.,	19,800	18,700	16,800	22,500	Calm, warm.	– – –	60
5.15 P.M.,	20,000	19,400	16,900	22,700	Calm, cool.	Sap ceased flowing.	59
6.30 P.M.,	20,000	19,600	16,900	23,000	Calm, cool.	– – –	57
Averages,	21,769	19,738	18,576	23,753			

The data obtained from hourly readings on the north, south, east and west sides of the tree are given in Table IX. These were taken from the same tree (rock maple) as the records shown in Table I., and while they were continued only for one day, they undoubtedly show typical variations which occur. The resistances given are for 10 feet of the tree trunk, and the day selected for the readings was free from clouds, the sun being quite bright throughout the day for this period of the year (April 27).

At times, however, a slight haze was present which affected to some extent the intensity of the light. The highest resistance was shown in the early morning, when the temperature was the lowest, and as it had become warmer the resistance decreased. The lowest resistance occurred at 2.15 P.M., after which time there was a slight increase in the resistance. It will be noticed, however, that the least increase in the resistance after 2 P.M. occurred on the west side of the tree, which received at that time the benefits of the heat from the sun's rays during the afternoon. On the other hand, the north, east and south sides showed a greater increase for this period, as they were more or less shaded from the sun's rays. The north side of the tree gave the highest average resistance, followed by the east, south and west sides. The lowest average resistance occurred on the west side of the tree.

Sap commenced flowing freely at 9.15, and at 2.15, the time of the lowest resistance, it had commenced to cease flowing. As is well known, there is a relationship between the flow of sap and temperature, but there is no indication from these observations or from any of our experiments that there is any relationship between resistance and flow of sap.

Experiments with Cut Branches of Trees.

A number of resistances were obtained from cut branches of maple trees by Mr. Chapman. These were taken when the trees were in a dormant condition, and in some cases when the buds were developing.

Experiment A.

A maple branch 1½ inches in diameter and several feet long was used for this purpose. The branches showed slight bleed-

ing at first. Heavy galvanized iron nail electrodes were driven into the branch 20 inches apart, and several half-hour readings were taken. The branches were left out of doors where the temperature varied only a few degrees, and at the time the readings were taken it was just above freezing. The results follow: —

	Ohms.
8.30 A.M.,	136,000
9.00 A.M.,	132,000
9.30 A.M.,	131,000
10.00 A.M.,	132,000
10.30 A.M.,	120,000

This experiment was repeated several times with approximately the same results, and is not conclusive as regards influences of temperature.

Experiment B.

The same branch of maple was kept in the laboratory for five days at a room temperature (about 70° F.), the only difference between this experiment and the one preceding being the fact that the electrodes were placed 1 foot apart instead of 20 inches. The readings obtained are as follows, taking half-hour periods: —

	Ohms.
8.30 A.M.,	72,000
9.00 A.M.,	72,000
9.30 A.M.,	74,000
10.00 A.M.,	75,000
10.30 A.M.,	77,000

Very little variation was shown in the resistances.

Experiment C.

A branch of another maple of about the same diameter as the preceding was cut under water and allowed to stand at room temperature for five days, when a fresh cut was made under water. During this time the leaves and flowers had started, and there was evidently some transpiration. The electrodes were 1 foot apart. The following readings were obtained: —

	Ohms.
8.30 A.M.,	64,400
9.00 A.M.,	65,000
9.30 A.M.,	68,000
10.00 A.M.,	67,000

It will be seen that these resistances were all ranged between 64,000 and 67,000, and coincide very closely with those given in Experiment B.

Experiment D.

Another experiment, using the same branch as was used in Experiment C, was undertaken, but in this case the water in which the branches stood was heated to a temperature ranging from 100 to 130° C. The readings were taken at half-hour intervals, with the following results: —

	Ohms.
9.30 A.M.,	67,000
10.00 A.M.,	68,000
10.30 A.M.,	67,500
11.00 A.M.,	67,600
11.30 A.M.,	73,000
12.00 M.,	72,000
1.00 P.M.,	72,000
1.30 P.M.,	71,000
2.00 P.M.,	69,000
2.30 P.M.,	70,000
3.00 P.M.,	73,000
3.30 P.M.,	75,000
4.00 P.M.,	76,000

The rise in temperature had little or no effect on the resistance. On the other hand, the readings in some cases were slightly higher.

Experiment E.

The same branch was used in this experiment. After standing over night and the water brought to room temperature a space of ½ inch down to the wood was removed halfway between the electrodes; in other words, the branch was girdled for this distance. The following readings were obtained: —

	Ohms.
8.30 A.M.,	122,000
9.00 A.M.,	121,000
9.30 A.M.,	124,000

all averaging not over 123,000. The results here show greatly increased resistances as the effect of girdling.

Experiment F.

The same branch was used here as in E, except the girdling was increased to 3 inches. The following readings were taken: —

	Ohms.
1.00 P.M.,	128,000
1.30 P.M.,	130,000
2.00 P.M.,	127,000
2.30 P.M.,	130,000
3.00 P.M.,	129,000

It will be noticed that these readings were slightly higher than those in Experiment E, due to girdling.

Experiment G.

The same branch under the same conditions was used for this experiment, except that the branch was completely girdled between the electrodes. The results follow: —

	Ohms.
8.30 A.M.,	150,000
9.00 A.M.,	151,000
9.30 A.M.,	150,000
10.00 A.M.,	150,000
10.30 A.M.,	149,000

It will be noticed that the readings obtained here are higher than in F or E, due to the greater girdling. These experiments demonstrate that the wood gives much higher resistance than the cambium, and shows that the resistance increased as the bark and cambium were removed. The highest resistances were given where there was the greatest amount of girdling. Even cutting away the bark for a distance of ½ an inch or more in each direction from the electrodes greatly increases the resistance. This is what occurred in the experiment shown in Table V., where the bark was cut away from the electrodes, whereas in experiments shown in Table VIII. for the same distance, and where no bark was removed, the resistances were much lower.

Experiment H.

In this experiment a freshly cut branch about 1 inch in diameter was used, and the bark cut away for a space of 1 inch

around the electrodes, which were inserted 1 foot apart, as in the other experiments. The branch was placed in water at room temperature of from 68° to 70° F. The following results were obtained: —

	Ohms.
10.00 A.M.,	110,000
10.30 A.M.,	100,000
11.00 A.M.,	100,000
11.30 A.M.,	105,000

Experiment I.

The same branch was used as in Experiment II. and a fresh cut made under water, the water being heated for three hours at a temperature ranging from 149 to 150°. After three hours at this temperature the following readings were obtained: —

	Ohms.
1.30 P.M.,	140,000
2.00 P.M.,	135,000
2.30 P.M.,	138,000
3.00 P.M.,	142,000
3.30 P.M.,	150,000

It will be noted that the resistances were higher here than in the others, although the temperature of the water in the latter case was very much higher than in the former experiment.

Experiments with Small Plants.

Some experiments were made with small plants in the greenhouse in February to determine the electrical resistance. For this purpose we made use of tobacco plants in pots, the plants being 3 feet high. The results of these experiments, made by Mr. Chapman, follow: —

TABLE X. — *Showing the Electrical Resistance of a Tobacco Plant (Nicotiana tabacum, Linn.).*

[Resistance in ohms.]

Time.	Experiment I.	Temperature (Degrees F.).	Experiment II.	Temperature (Degrees F.).	Experiment III.	Temperature (Degrees F.).	Experiment IV.	Temperature (Degrees F.).
8.00	-	-	-	-	132,000	-	-	-
8.30	-	-	-	-	130,000	68	128,000	62
9.00	131,000	-	108,000	60	136,000	73	129,000	63
9.30	116,000	-	140,000	60	134,000	78	124,000	63.5
10.00	110,000	-	137,000	61	110,000	83	127,000	63
10.30	133,000	-	146,000	62	129,000	79	-	-
11.00	117,000	-	151,000	62	136,000	73	128,000	64
11.30	117,500	87	147,000	61	133,000	77	123,000	67
12.00	125,000	84	147,000	62	116,000	82	121,000	71
12.30	-	-	-	-	-	-	-	-
1.00	137,000	81	136,000	62	-	-	-	-
1.30	126,000	80.5	147,000	63	143,000	69	-	-
2.00	129,000	80.5	-	-	144,000	65	-	-
2.30	131,000	80	139,000	63	143,000	67	-	-
3.00	125,000	81	135,000	63	151,000	67	-	-
3.30	128,000	70	144,000	63	155,000	66	-	-
4.00	153,000	67	146,000	59	161,000	64	-	-
4.30	156,000	67	143,000	61	161,000	62	-	-
5.00	156,500	66	150,000	60	164,000	60	-	-

The object of the experiment was to determine what influence other factors might have on resistance, such as temperature, etc., but more particularly whether variations in temperature were discernible in resistance. The plants were under tolerably uniform conditions, although the temperature varied, as will be seen in the tables. Platinum electrodes were used, these being driven into the plant at a distance of 14 inches apart. One was driven in at the base and the other near the apex of the stem. There were no very marked coincidences between the changes of temperature and resistance in these experiments, but it should be remarked that the lowest resistance coincides with the highest temperature in Experiments I., II. and IV., while in Experi-

ment III. there was little variation in temperature, although variation in resistance occurred. In averaging up the temperature and resistance for those periods where all the data are present it is found that there is a relationship between the temperature and the resistance. For example, it was found that the lowest temperature occurred on the last three periods, that is, from 4 P.M. to 5 P.M., and that the highest average resistance occurred during these periods also. On the other hand, the lowest average resistance coincides in a general way with those periods which gave the highest temperature readings.

Relation of Electrical Resistance to Flow of Sap.

Some observations were made on a rock maple in regard to the relation of electrical resistance to the flow of sap, but these were not extensive and lasted only a few days. The following results were obtained by collecting sap on the north, south, east and west sides of the tree. The amount of sap represents the amount of flow between 9 A.M. and 12 M., and 12 M. and 4 P.M., but the table gives the total amount obtained as well as the average resistances for the whole period.

	North.	South.	East.	West.
Average resistance, ...	34,720	40,340	32,217	37,140
Total sap flow in cubic centimeters, .	5,945	6,180	5,820	5,150

The highest average resistance and greatest sap flow occurred on the south side of the tree. The sequence of the average resistance was as follows: north, south, east and west, and that for the sap flow, south, north, east and west. Our records, moreover, showed that sap flowed more freely in the morning than in the afternoon, also that the average resistance was higher in the morning than in the afternoon. Since these observations were not prolonged the results are not conclusive, but we do not believe that electrical resistance is affected materially by sap flow. Since our resistance readings were obtained from the trees offering the least resistance, which is no doubt in all cases the cambium layer, it is questionable whether sap flow, which is characteristic of the woody tissue, would affect our results.

The flow of sap, as is well known, is influenced by various conditions, a very important one being night temperature, as well as the conditions which prevail during the day. Temperature records were taken for the same period, but there was little or no direct relation between the temperature of this period and the sap flow. In all cases the air temperature was at freezing or below this point during the night, while in the daytime it ranges from 43 to 57°.

Jones, Edson and Morse [1] found that the maximum yield of sap occurred quite generally between the hours of 9 A.M. and 12 M. They also maintain that on a typical sap day the tree will yield more sap and sugar on a southern exposure than on any other, while on a cloudy day, when all the sides of the trees are subject to a uniform temperature, there is little or no difference in the sap flow as regards the cardinal points of the compass. It is known that the percentage of sugar varies in the tissues of a tree from day to day, and it is doubtful whether this variation in the chemical composition of the sap, or even the amount of flow, would affect resistance even if our observations were confined to the woody tissues alone. This opinion is based on laboratory experiments.

Electrical Resistance of Different Tissues.

It might be expected that there would be found considerable difference in the electrical resistance of various trees, as well as of the different tissues found in trees. The heartwood, sapwood, cambium, bark and sieve tubes possess quite different properties and functions, and their electrical resistance would naturally vary to a large extent. The living cells containing protoplasm, such as are found in the cambium, present the least resistance, as would seem from various observations on lightning discharges. The minute burned channel found in trees caused by comparatively insignificant lightning discharges follows down the cambium, indicating that this is the line of least resistance. Moreover, by driving electrodes into a tree to different depths and measuring the resistance it can be shown that the least resistance occurs in the region of the cambium.

[1] The Maple Sap Flow, by C. H. Jones, A. W. Edson and W. J. Morse, Vt. Agr. Exp. Sta., Bul. No. 103, December, 1903.

The resistance, however, may equal 25,000 ohms more or less, in 10 feet of the trunk of an elm or maple tree. This constitutes a comparatively high resistance. The resistance of the sapwood is very much greater, and probably that of the heartwood is even higher than that of the sapwood.

In determining the electrical resistance it is necessary to know the path or course of the current, and the only manner in which the electrical resistance of different tissues can be determined accurately is by isolating the tissues. By girdling a tree and scraping the trunk down to the solid wood we can get the resistance of the wood. Mr. Chapman found the resistance of a freshly cut rock maple stem, 1½ inches in diameter, to be 70,000 ohms when intact, *i.e.*, with the bark on, but 150,000 ohms when the bark was removed. The electrodes were 1 foot apart.

Some experiments which have been made indicate that next to the cambium the phloem has the least resistance, followed by the sapwood. The outer bark appears to offer the most resistance, but when this is moist, as during rain storms, the resistance may be somewhat decreased. When leakage occurs, owing to grounding of the electric currents from high tension wires in moist weather, burning results, but this is due to the presence of a film of water on the bark, and what is termed "arcing" occurs. The resistance obtained from an elm tree, with the electrodes 10 feet apart and in contact with the cambium, was 10,698 ohms, whereas when the electrodes were inserted into the middle of the cortex or phloem we obtained 11,300 ohms resistance. When driven ¼ inch into the wood the resistance was 98,700 ohms. The outer bark gave 198,800 ohms resistance, but when the electrodes were inserted slightly deeper into the bark we obtained 109,900 ohms. It must not be understood, however, that these readings gave the electrical resistance of 10 feet of the various tissues enumerated except in the case of the cambium, since if these tissues were isolated the resistance would be much greater. They show that there is much difference in the resistance of different tissues, but in all cases here we obtained merely a resistance of the cambium, together with that of a part of the other tissues, which the current had traversed from its various points of entrance to the cambium.

It is quite evident from our observations on the resistance of trees that the cambium gives the least resistance, the phloem next, and it is not at all unlikely that in some trees there may be some variation in this respect.

The resistance given by small tree trunks and woody stems, even for small distances, is quite large. About 4 feet of a young pear tree, with a maximum diameter of stem equal to 1 inch, gave a resistance of about 300,000 ohms, and the resistance given by a tobacco plant in which the distance between the electrodes was only 14 inches, was much higher (110,000 to 165,000 ohms) than that shown by trees. In the case of the pear tree, which was in a large box, filled with soil, one of the electrodes (metal plate) was in contact with the small roots, the other being in contact with the apex of the plant.

The presence of water and various salts undoubtedly plays a rôle in resistance, and it might be expected that the various plastic substances in the plant would influence resistance.

The path of a current in a tree, as already stated, follows the line of least resistance, but this line may not necessarily be a straight one between one electrode and another. Although in many lightning strokes a straight line is generally followed, we have seen instances where the whole cambium zone was involved, and when the tissue in a tree is twisted the discharge will follow the tissue. A lightning discharge may therefore completely circle a tree trunk, passing from the apex of the tree to the ground. In earth discharges the path follows up the trunk and is generally diverted to the branches, often causing them to split. When heavy lightning discharges occur and the tissues of the tree become shattered, as is often the case, the line of least resistance seems to be an unimportant factor, and in this respect the electric discharges resemble an avalanche in their behavior. In some of our experiments, where trees were connected with wires carrying relatively high currents and the electrodes were 1 foot apart vertically, all of the injury was done by burning on one side of the tree in close proximity to the electrodes, but even here the burning of the tissue covered an area of more than 1 foot in width on the trunk. Burning under these conditions, however, occurred only when the bark of the tree was moist, and was not caused by a decrease in resistance in the tis-

sue, but by the presence of a film of water, which is a far better conductor, on the bark, which became heated and killed the underlying tissue. In the case of some large trees which we observed and which had been killed by direct currents from trolley wires, the tissue was as a rule affected nearly equally around the entire trunk of the tree, although the point of contact was on one side of the tree. In both cases it was a heating of the film of water on the trunk caused by the escaping electric current which caused the injury.

The cambium ring is very insignificant in size, practically $\frac{1}{500}$ to $\frac{1}{1000}$ in diameter, and even on a large tree the total area is small. In all probability it is the protoplasm itself which offers the least resistance to the transmission of an electric current; and even if there were no continuity it would be necessary for the current to pass through a great many cell walls even for comparatively short distances on the trunk. In case the protoplasm was contiguous or there existed continuity, the strands would be so very small that they would undoubtedly offer some resistance. Whatever conditions prevailed trees showed relatively high electric resistances, a feature which is no doubt of some biological importance as trees are often struck by lightning. The high resistance of trees, therefore, is undoubtedly a protection in case of lightning strokes, since often the heat developed is enough to do only slight injury. On the other hand, if trees possessed tissue with relatively small electrical resistance they would be much more subject to injuries from burning from lightning strokes, and would be more seriously affected by currents from high tension wires. The electrical resistance of trees is so high that it is doubtful whether injury ever occurs to them from contact with low or even high tension wires except that produced by grounding when the bark of the tree is moist. Any escaping current which can be transmitted even through the least resistant tissue is likely to be insignificant.

The amount of current necessary to kill a plant depends upon its size, etc. A current equal to .01 amperes may be sufficient to kill a small plant, whereas a current ten times as great would cause no perceptible injury to a large tree even when passed through the tissue for months. The higher resistance shown by

small branches or woody stemmed plants may possibly be due to the presence of less conductive tissue, whereas in a tree the conductive zone, if we include the phloem, is larger.

It is known that there are minute currents of electricity in plants, but we have never noticed their effects on our galvanometers nor have we detected them by the use of a milliammeter. Trees frequently become charged with electricity, and sparks are given off from the apices of the leaves. Vegetation in general responds quickly to electrical stimulation, and trees undoubtedly play an important part in equalizing the differences in electrical potential between the atmosphere and earth. In this respect conifers appear to behave differently from deciduous trees, and in our experiments we have found that the atmospheric electrical potential under thick conifers was the same as that which characterizes the earth.

Relationship of Electrical Resistance to Other Factors.

We had little or no opportunity to observe the effects of winds, if such exist, on electrical resistance. Most of our records were taken while the tree was in a dormant condition. In some cases the trees were well protected from the winds. It is known that transpiration is increased by wind, and the movements of water in the tissues of the tree are accelerated. No relationship, however, between the wind and electrical resistance has been noted by us in comparing the records of the local meteorological station with our data, neither was there any specific relationship observable between barometer pressure and electrical resistance. A careful study of the humidity conditions, also, did not seem to affect the electrical resistance so far as we could observe. Aside from the temperature effects coincident with light intensity no special changes in resistance were observable except such as would naturally follow from the variations in temperature.

Influence of Temperature on Resistance.

The most important factor which we have observed as influencing the electrical resistance of trees is temperature. The effects of temperature on various metals give rise to an increased

resistance, whereas plant tissues show a greatly reduced resistance when heated.

Our numerous experiments in subjecting seeds to electric currents have shown that when they have been soaking in water for some hours and are quite moist, and a relatively strong current is passed through them, the resistance is largely decreased owing to the development of heat, and the current increases very perceptibly. This also occurs to plants when subjected to currents of electricity of sufficient intensity, as it induces heat. The injury caused to plants by electricity generally arises from decreased resistance, which is likely to follow after a more or less prolonged application of the current; in other words, the injurious effect is caused by heat, although it is possible that electricity will kill plants without generating heat sufficient to injure the protoplasm.

Experiments made some years ago by us seemed to indicate that when strong currents are applied to small plants and they become excessively heated, after a short period of time the protoplasm is destroyed, and the current, which first increases in strength very rapidly, suddenly drops to almost nothing.

A low temperature in trees gives rise to a high resistance, and a high temperature to a low resistance; in other words, the resistance of trees resembles that of moist seeds in their behavior to temperature, and the relationship between temperature and resistance is quite general. There may be, of course, other factors which influence resistance besides temperature, such as, for example, the degree of moisture in the tissue, as well as the nature of the substances in the tissue.

The relationship existing between temperatures and resistance is shown in Figs. 1, 2 and 3. Fig. 1 shows the curve given by an elm tree, and is based upon the data given in Table II., being the average daily resistance obtained from the north, south, east and west sides of the tree during April, the upper curve with broken lines being that of the mean temperatures for the days when the observations were made. In Fig. 2 A the average electrical resistance of the south side of a maple tree is shown from the data given in Table VIII. The readings are averages of three daily readings at 8 A.M., 12 M. and 4 P.M., and in B is given the average electrical resistance of a maple tree from data

obtained in Table I., the curve being based on daily readings on the north, south, east and west sides of the tree. All of these figures show that there exists a marked relationship between the temperature curve and that for the electrical resistance, since as the temperature curve goes up the resistance curve goes down.

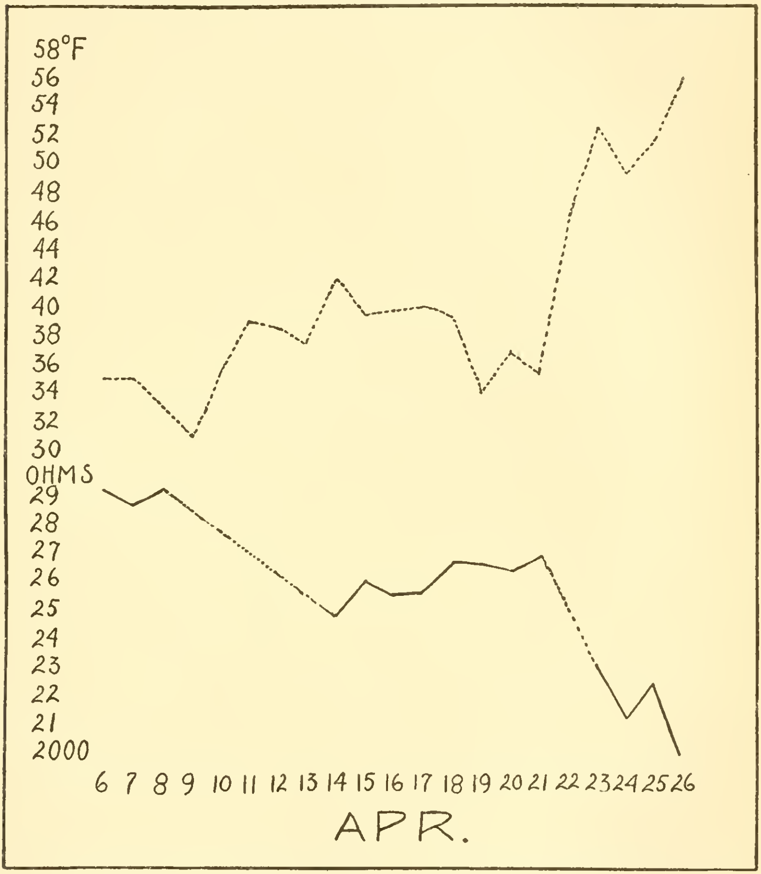

FIG. 1. — Showing curve of electrical resistance and temperature of elm, *Ulmus Americana* (Table II.). The lower curve gives the average resistance of the north, south, east and west sides of the tree from April 6 to 26; the upper curve gives the mean of the minimum and maximum temperature for the same period obtained from the local meteorological station.

In Fig. 3 is shown the hourly temperature and electrical resistance of the north side of a maple tree for a single day, the data being obtained from Table IX. In both Figs. 1 and 2 the temperature is taken from mean temperature records, while in the case of Fig. 3 they correspond with the hours of observation.

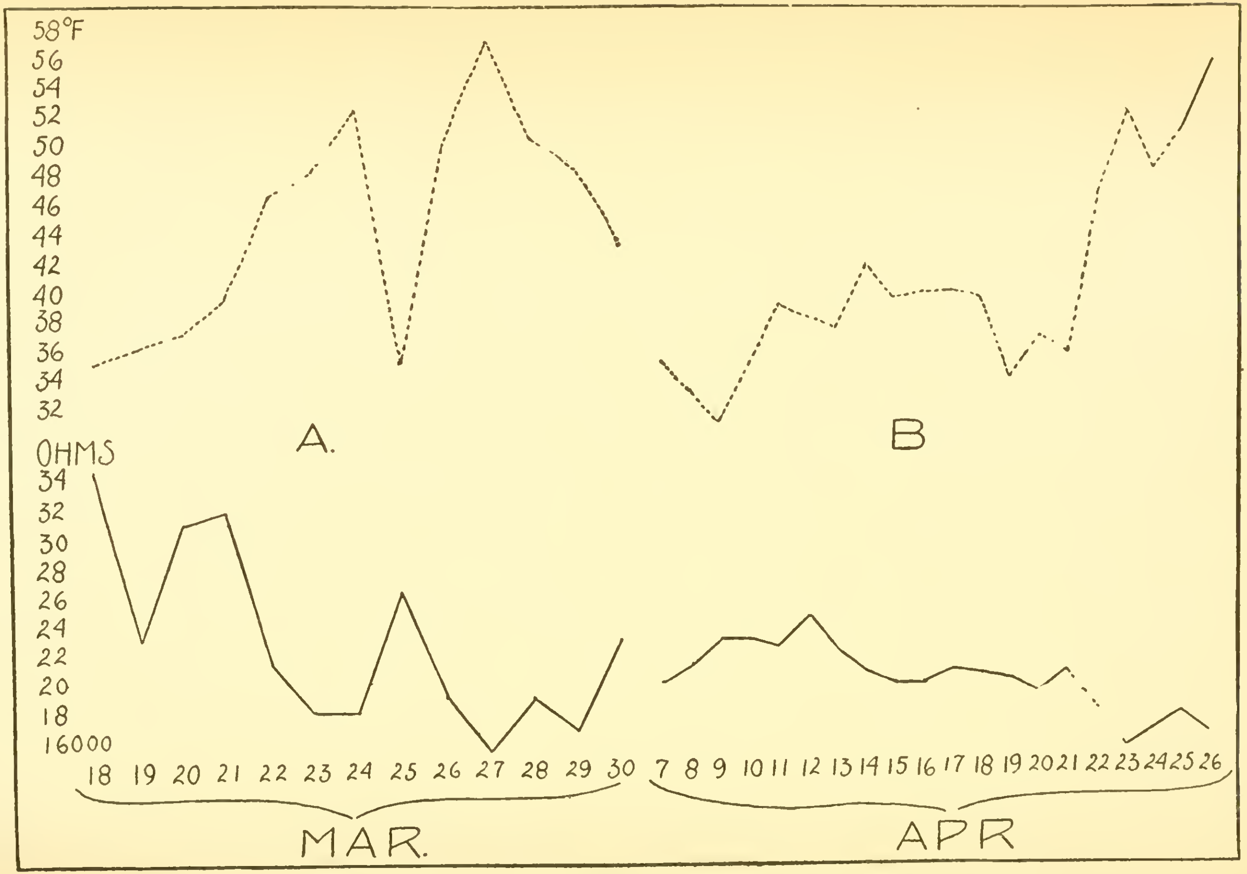

FIG. 2. —Showing electrical resistance and temperature curve of maple tree, *Acer saccharum*. The lower curves give the resistance of trees in ohms; the upper curves give corresponding mean temperatures obtained from the local meteorological station. A. Resistance given by the south side of a maple tree from March 18 to 30, inclusive, the resistance being averages of three daily observations taken at 8 A.M., 12 M. and 4 P.M. (See Table VIII.) B. Average resistance of the north, south, east and west sides of a maple tree. Observations taken daily from April 7 to 26. (See Table I.)

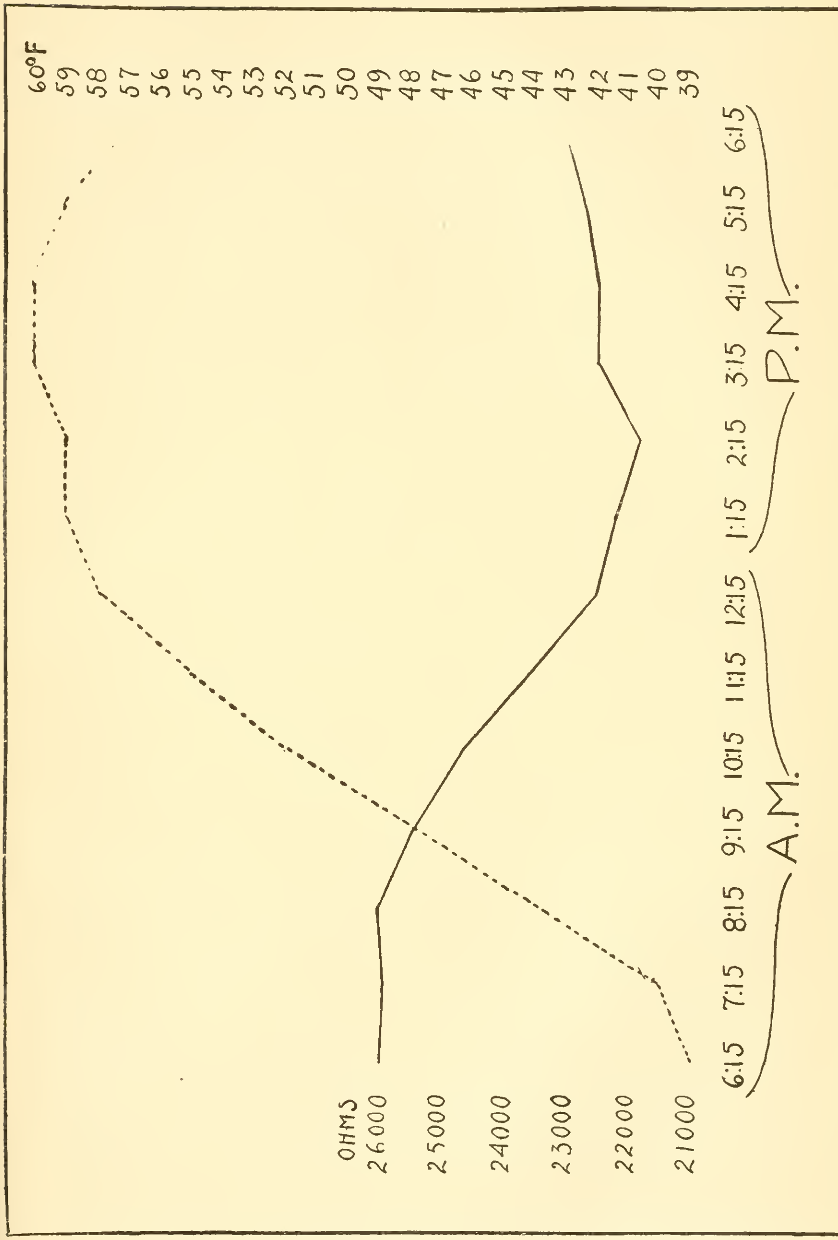

FIG. 3. — Showing electrical resistance and temperature curve of north side of maple tree, *Acer saccharum*. (See Table IX.) Observations taken hourly for one day, from 6.15 A.M. to 6.30 P.M. Lower curve represents the resistance curve, and the upper, the hourly temperature obtained from Draper records of the local meteorological station.

In the curve shown in Fig. 3 it will be observed that there is a close relationship between temperature and resistance.

Light, so far as we have observed, influences resistance only so far as it modifies temperature. The southeast side of the tree receives the most light, since the morning light is more intense than the afternoon light. Photosynthesis is more active on that side of the tree, and growth greater. Since there is a relationship between photosynthesis and light intensity, and also between growth, there occurs more activity, as a rule, on the southeast side of the tree than on any other, but whether the greater flow of plastic substances in any given tissue would affect resistance, our data do not show. So far, however, as the greater light intensity is associated with increased temperature, we should expect to find corresponding modifications in resistance.

Influence of temperature is shown in the difference existing between the resistance occurring on the north and south sides of trees. Some of our temperature records taken on the north, south, east and west sides of a rock maple were not satisfactory on account of the constant breakage of thermometers. These temperatures were taken three times daily, at 8 A.M., 12 M. and 4 P.M., for a period of five days. The records, however, gave the lowest average temperature on the north side of the tree, followed by the west, east and south sides respectively.

Other observations carried on for a brief period on a rock maple tree gave the following results. In both cases the thermometers were inserted into holes bored in the tree. The records obtained in the second series of observations, which are averages for a period of seven days, are as follows: —

The average of three observations daily, at 8 A.M., 12 M. and 4 P.M. on the north, south, east and west sides of a rock maple tree, gave the lowest temperature on the north, this being followed by the west, east and south sides respectively. These temperatures were taken in December, when the tree was in a dormant condition, and the temperature given by the north side of the tree was invariably the lowest.

Jones, Edson and Morse obtained careful temperature records from a rock maple tree. The observations were made on the north and south exposures, and extended from February 8

to March 20, and were made at 8 A.M., 12 M. and 6 P.M. each day. Corresponding air temperatures were made for the same period. These observations were made with centigrade thermometers, which were carefully protected from external influences. We transposed their readings into Fahrenheit and found that the average temperature given by the south side of the tree was 31.43° F., while that for the north side was 30.57° F. The air temperature for the same period, as might be expected, was variable, averaging slightly higher than that for the inside of the tree.

The average temperature readings obtained by Jones, Edson and Morse from the north and south sides of the tree showed that the temperature on the north side was about 3 per cent. lower than on the south side. The average obtained from all our electrical resistances and temperature readings are given below in sequence: —

	Average Electrical Resistance.	Average Temperature of Trees (Degrees F.).
North side,	27,081	30.91
West side,	25,714	32.14
South side,	25,566	33.60
East side,	23,708	32.28

It will be noticed that the highest average resistance of trees was given by the north side, followed by the west, south and east sides, and this sequence was closely followed by the temperature readings, the lowest being given by the north, followed by the west, east and south sides. The temperature readings lasted seven days only, and were too incomplete to obtain a true average. It will be noticed, however, that there was a difference of about 8 per cent. between the resistance of the east and west sides of the tree, a feature which would result from the greater intensity of the morning light. In our temperature readings, which are probably not as good averages as those obtained by the authors noted above, we find that the north side of the tree showed a temperature equal to 7 per cent. lower than the south side, as compared with 3 per cent. given by Jones, Edson and

Morse, whereas the average resistance for the north side of the tree runs about 5 per cent. more than that for the south side. The relationship of temperature to resistance manifests itself throughout; the higher temperature giving rise to a low, and conversely a low temperature giving rise to a high resistance.

The sun strikes the tree on the east, south and west sides, and each side is exposed for the same length of time; but the angle of the sun is variable as it strikes the tree's surface. In the early morning and late afternoon the sun's rays are more or less at right angles to the tree trunk, whereas at noon the angle is more oblique. The surface of a tree is not a good reflector of light and heat, and in the early morning and late afternoon, when the rays are more at right angles to the surface of the trunk, there is less loss of light and heat by reflection. Assuming that the light intensity is uniform throughout the day, and that the temperature is the same, we would expect to find fairly uniform resistances for the east, south and west sides of the tree. This, however, is not the case, as the temperature is seldom uniform, neither are the light conditions, as is shown by the flow of sap.

The north side of the tree gives the highest average resistance, followed by the west, south and east sides. From the point of view of influence of temperature this might be expected, especially during seasons when there is considerable difference between the night and day temperatures, and very likely for long periods of observations thermometers placed in trees would demonstrate this. Electrical resistances taken in the afternoon usually run lower than those taken in the morning on all sides of the tree, which results from a general increase in the temperature of the surrounding air and of the tree occurring in the daytime. The electrical resistance is less in the warm than in the cold months, and less on warm than cold days. In the morning the sun affects the east side of the tree most markedly, and in the afternoon the west side.

In experimenting with cut branches of maple trees we did not find, however, that this held true. The resistances obtained from branches placed out of doors when it was cold were in no wise different from those taken from the same branch when placed in the laboratory, where it was warm, or even when

they were placed in hot water, although trees and various potted plants with an intact root system all showed the influence of temperature on resistance.

Conclusions.

1. The electrical resistance of trees shows a close relationship to temperature, their higher resistance corresponding with the low temperature, and the low resistance corresponding with the higher temperature.

2. The electrical resistance of trees is lower during warm than cold days, and less during warm than cold seasons. It is usually less during afternoons than mornings; in other words, it corresponds to changes in the temperature.

3. The average electrical resistance of trees is highest on the north side, followed by the west, south and east sides respectively.

4. The temperature of trees given by our experiments, which were of limited duration, is less on the north side, followed by the west, east and south sides, and coincides in a general way with the variation in the resistance of the different sides of the tree. Extensive observations regarding temperature and resistance would undoubtedly show very close relationship between these two factors.

5. The average electrical resistance for the east side of the tree is about 8 per cent. lower than the west side, due, undoubtedly, to differences in temperature existing between the east and west exposures. The difference, however, in the light intensity of morning and afternoon is variable from day to day and from year to year, and may range from 1 or 2 per cent. to 30 per cent. or more per month, but averages between 10 per cent. and 17 per cent. per annum.

6. The difference in the average electrical resistance of the north and south sides of the tree is about 5 per cent., the average difference in the temperature being about the same.

7. The cambium layer offers the least electrical resistance, as shown by lightning discharges and by our experiments. This is followed by the phloem and sapwood.

8. Small plants and branches of trees in general give higher electrical resistances than trees, probably due to the greater

amount of conductive tissue, possessing less resistant qualities in the trees.

9. The high resistance and consequent nonconductivity of trees serves, no doubt, as a protection for the tree against lightning stroke and other electrical discharges.

10. Sap flow did not, so far as we were able to observe, exert any influence on the electrical resistance.

11. Temperature constitutes a determinative factor in variations of electrical resistance of trees. Other meteorological factors, such as relative humidity, barometric pressure, winds, etc., exert no discernible specific influence.

THE CHEMISTRY OF ARSENICAL INSECTICIDES.

BY E. B. HOLLAND AND J. C. REED.

General Introduction.

The work on arsenical insecticides, at the chemical laboratory of this station, has advanced sufficiently to warrant a second report [1] on the subject dealing particularly in this instance with the composition, manufacture and use of Paris green, lime arsenite and lead arsenate. In this connection it may be of interest to consider briefly the monetary loss resulting from injurious insects, and note the insecticides available to check their depredations previous to the introduction of arsenicals.

The aggregate loss in the United States from insect injury to agricultural products of all kinds including live stock, forest and shade trees and ornamental plants, together with the subsequent damage to manufactured goods, is impossible to compute with any degree of accuracy. It has been estimated [2], however, at $1,000,000,000 annually, and may exceed that amount. Without question the successful production of many, if not most, crops is dependent in a large measure upon their protection from noxious insects. The rapidity with which such pests multiply and are disseminated, and the readiness with which they adapt themselves to new conditions, occasionally undergoing considerable change in character, size and appearance, demands thorough scientific treatment for their control, as eradication is practically impossible. The tendency of injurious insects to feed on a greater variety of plants and to become more destructive in a new country than where indigenous, due to more favorable climatic conditions or absence of natural enemies, renders the problem even more difficult to handle.

[1] First report in Mass. Exp. Sta. Rept., 23, p. 122 (1911), entitled The Determination of Arsenic in Insecticides.

[2] Economic entomologists allow 10 per cent. loss on all produce.

The substances formerly employed as insecticides were usually characterized by offensive or caustic rather than poisonous properties. An acrid or bitter taste and a pungent odor were evidently deemed necessary qualifications for insecticides, and the more unpleasant the greater merit they were supposed to possess. Among the more prominent, enumerated by early writers,[1] might be mentioned water, hot water, brine, urine, lye, lime water, whitewash, clay wash, soapsuds, vinegar, petroleum, tar infusion, turpentine, fish oil, whale oil, sulfur, decoctions of aloes, dwarf elder, pepper, quassia chips, rue, tobacco, walnut leaves, wormwood and dustings of wood ashes, quick lime, soot, sulfur, hellebore and tobacco. It is not surprising that the use of such repellants (as a class they could not be designated otherwise) was often ineffectual. The farmers were hampered further by a very imperfect knowledge of the life history and habits of the insects to be combated. To be sure, some of the materials had insecticidal value, largely, however, as contact [2] rather than as internal poisons, effective as an irritant, also, by penetrating the cuticle or entering the body tissue through breathing pores, and possibly in some cases by closing the tracheæ,[3] resulting in the asphyxiation of the insect. The application of these substances, singly or several together, constituted the best recognized treatment both in this country and abroad previous to 1860–70.

Several materials deserve especial notice not only because they possess merit, maintaining a place even to the present time, but more particularly on account of the part taken in the development of modern practice. These are hellebore, pyrethrum, kerosene and lime-sulfur. Hellebore, though known to possess poisonous properties, received little attention until about 1842 in England [4] and later in this country.[5] Pyrethrum has been a

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[1] Wm. Speechly, A Treatise on the Culture of the Pine-Apple (1779); J. A. E. Goeze, Geschichte einiger schadlichen Insecten (Leipzig, 1787). Cited by E. G. Lodeman, The Spraying of Plants, p. 5, (1902); Samuel Deane, The Newengland Farmer or Georgical Dictionary, 2d edition (1797); Wm. Forsyth, A Treatise on the Culture and Management of Fruit Trees (1802); Jas. Thatcher, The American Orchardist (1822); Thos. G. Fessenden, The New American Gardener, 6th edition (1832); Wm. Kenrick, The New American Orchardist (1833); Thos. Bridgeman, The Young Gardener's Assistant (1857); J. C. Loudon, The Encyclopedia of Gardening (1878).

[2] How Contact Poisons Kill, Geo. D. Shafer, Mich. Exp. Sta. Tech., Bul. No. 11 (1911).

[3] No attempt was made to differentiate tracheal poisons from contact poisons in general.

[4] A. Mitchell in Gard. Chron., 1842, p. 397.

[5] J. Harris in Country Gentleman, 1865, p. 413.

commodity of southwestern Asia for a long time, but appears to have been overlooked by early European and American agriculturists, being introduced into France about 1850. The efficacy of kerosene, fish and whale oils, and turpentine was acknowledged comparatively early, though they were seldom used on account of the liability to injure the plant. The fact that such substances must be miscible with water to be applied safely was recognized long prior to an understanding of how it could be accomplished. An emulsion [1] of kerosene with soap and water was apparently not used until 1870. Soap and water has probably been more extensively employed in the past than any other substance, both for its effect and as a vehicle. Whale oil soap [2] was recommended in 1842. Lime and sulfur were almost invariably mentioned by early writers on insecticides. They jointly appeared in a number of mixtures, and where heat was employed in their preparation [3] partial combination, at least, must have taken place. This product was a forerunner of the lime-sulfur compounds which have since proved so valuable in checking the San José and other scales.

While the above summary may fail to convey a clear understanding of the subject, it will serve to show that practically no active "food" poison had been used as an insecticide previous to 1860.

The advent of the potato beetle [4] in Nebraska in 1859 and its rapid spread eastward created a demand for a more powerful insecticide than those commonly employed. In a measure this was true also of the imported currant worm which appeared in the eastern States about 1858. The poisonous nature of arsenic was well understood, and its salts would naturally be expected to possess a like property. Paris (Schweinfurt) green had long been known as a pigment under various trade names and was first applied [5] as an insecticide for the potato beetle about 1868, from which time its use was gradually extended to the cotton worm, cankerworm, codling moth and other insects. Subsequently a number of other arsenicals were recommended, of

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1 Geo. Cruickshank in Gardener's Monthly, 1875, p. 45.

2 David Haggerston in History of Mass. Hort. Soc., 1829–78, p. 256.

3 Kenrick, *loc. cit.*, p. XXXVI., and for grape mildew, p. 328 (1833).

4 C. V. Riley, Potato Pests, pp. 12–24 (1876).

5 Geo. Liddle, Sr., in Amer. Ent. 1, p. 219 (1869).

which Scheele's green [1] in 1875, London purple [2] in 1877, lime arsenite [3] in 1891 and lead arsenate [4] in 1893 are the most important. Paris green and lead arsenate are to-day the most extensively employed food poisons for leaf-eating insects. Lime arsenite is more particularly a farm preparation. Scheele's green and London purple have been largely superseded by the other compounds.

The Investigation.

The object of the investigation, planned by Dr. H. T. Fernald of the entomological department, was "to ascertain why and under what conditions insecticides burn foliage." The principal arsenicals were to be applied "under differing known conditions of light, temperature and humidity," and where injury resulted, its character and extent carefully determined. Work of this type would naturally extend over a considerable number of growing seasons to furnish sufficient data to warrant positive deductions. The chemical department of the experiment station was required to co-operate so far as to provide the necessary amount of chemicals of known composition, suitable for the purpose intended, together with any information relative to solubility, hydrolysis and power of suspension, that would be of service in their application.

At the outset the laboratory phase of the project appeared an easy matter, — simple analytical work on a relatively small number of samples of similar nature. In February, 1908, letters were sent to several large manufacturers of high-grade chemicals stating the object of the investigation and asking if they could supply Paris green, copper arsenite, lime arsenite and lead arsenate of the necessary purity and, if not, the best method of securing such salts. The replies were rather unsatisfactory, though the order was finally placed with a firm making a specialty of guaranteed reagents. The dry salts were received, but on examination proved unfit for the purpose intended. Work on methods of analysis and study of arsenical reactions were continued, so far as other duties would permit, during the next two years.

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[1] C. V. Riley, Potato Pests, p. 67.
[2] E. G. Lodeman, Spraying of Plants, p. 65.
[3] N. Car. Exp. Sta., Bul. No. 77b, pp. 7–8, (1891).
[4] Mass. Bd. Agr. Rept., 41, p. 282 (1894).

In March, 1910, a persistent effort was made to obtain all help possible in furtherance of the work, as it was then thought that it would be necessary for us to prepare the salts in the station laboratory. A circular letter was sent to manufacturers of chemicals, particularly those firms making insecticides, asking for information relative to the general process of manufacture of the several products. A statement was inserted to the effect that the station was not in quest of trade secrets, but merely wished to secure a fairly broad knowledge of the difficulties attending the manufacture, and of the impurities likely to be present, so as to be in position to handle the problem intelligently. The replies in general contained little or no information of value. Two large concerns, however, took a more liberal view of the matter and readily furnished any data at their command. One of these companies volunteered to supply any insecticides needed free of cost. Inasmuch as a manufacturer of arsenicals with adequate facilities was unquestionably in a better position to handle the matter, the offer was gratefully accepted. In May large, dry samples of Paris green, copper arsenite, lime arsenite and neutral and acid lead arsenates were received from the factory. A laboratory examination showed that not one of these specially prepared insecticides was entirely satisfactory, the Paris green alone being set aside for actual use in spraying tests.

The matter now began to assume rather a serious aspect. Was it possible to produce arsenicals of definite molecular ratios or not? Two companies had signally failed in the attempt, presumably using all the precautions they knew. Letters somewhat similar to those sent the manufacturers had also been addressed to several eminent chemists, requesting their opinions as to the preferable precipitants and conditions of manipulation to insure the proper equilibrium for the production of compounds of theoretical composition. The substance of their replies, while general in character, was to the effect that "the difficulties are inherent in the nature of the compounds," and that arsenites (particularly) are unstable, hydrolizing in the presence of water. The latter fact had long been a matter of record [1] and might excuse slight discrepancies in composition,

[1] See p. 186 of this article.

but the gross differences noted in the several samples were evidently due to incorrect methods of production. This view was substantiated by a large number of tests in the station laboratory, the resulting compounds varying in composition with differing conditions attending their preparation. To be sure, our work was conducted in a small way (2 to 3 ounces at most), but there was no reason to doubt that it would hold equally true on a commercial scale under like circumstances.

After having failed to obtain satisfactory salts from two different companies, and realizing more than ever the lack of manufacturing facilities in the laboratory, the matter was brought to the attention of one of the largest American manufacturers of analytical chemicals with whom the problem had previously been discussed. This firm agreed to undertake the preparation of the arsenicals, following general directions furnished by the laboratory. Dry calcium metarsenite and neutral and acid lead arsenates were received from them early in August, and while all were more or less impure the results, on the whole, were encouraging though showing the necessity of further study in order to give more specific directions. Precipitations under varying conditions were continued into January, 1911, at which time the data at hand warranted placing another order with the last-mentioned firm for acid lead arsenate and calcium metarsenite in form of paste. Explicit directions were furnished by this laboratory as to the method of manufacture. The resulting lead salt proved to be approximately 97 per cent. pure and was accepted. The first lot of lime arsenite was rejected, but the next shipment, over 94 per cent. pure, was accepted and employed in spraying tests during the summer of 1911, together with the acid lead arsenate and Paris green.

The above is a brief statement of some of the difficulties encountered in securing these three insecticides. In the papers that follow will be found under the headings of Paris green, calcium arsenite and lead arsenates a somewhat detailed description of the work performed in this laboratory relative to the several insecticides. Deductions drawn from a small number of samples must be considered indicative rather than conclusive, and their accuracy can be proved only by additional work.

A. Paris Green.

Historical.

Paris green was produced by Russ and Sattler [1] in 1814. The process was kept a factory secret until revealed by the independent investigations [2] of J. Liebig and Henri Braconnot in 1822. Liebig [3] treated 4 parts of verdigris in acetic acid with 3 parts of arsenous oxide in boiling acetic acid. The acid retained the material in solution until the excess was expelled. Braconnot [4] prepared a solution of potassium arsenite by boiling 6 parts of arsenous oxide with 8 of potassium carbonate, poured it while warm into 6 parts of copper sulfate, dissolved in a small quantity of warm water, and added acetic acid until the odor was perceptible. The methods of Liebig and Braconnot have since been modified by many chemists, but substantially they typify the two distinct manufacturing processes employed to-day, *i.e.,* the *instantaneous* and the *slow.*

The instantaneous method is thus described in Watts' "Dictionary of Chemistry:" [5] "Five parts of verdigris are made up to a thin paste, and added to a boiling solution of 4 parts or rather more of arsenous acid [6] in 50 parts of water. The boiling must be well kept up, otherwise . . . acetic acid must be added."

The slow process, as given by a manufacturing company,[7] is as follows: 1,000 pounds of blue vitriol are dissolved in 480 gallons of hot water and run into a 1,200-gallon "striking vat." Four hundred and fifty pounds of sodium carbonate (Solvay) are dissolved in 480 gallons of hot water, and 795 pounds of arsenic "sprinkled" on and boiled to remove carbonic acid.

The boiling arsenic solution is "let down" into the blue vitriol solution, the temperature of which is about 140° F., well stirred, and 210 pounds of acetic acid (100 per cent.) mixed with an equal weight of cold water added. The mixture is

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[1] B. B. Ross, Ala. Exp. Sta., Bul. No. 58, p. 4 (1894).

[2] H. Sattler, Ztschr. Angew. Chem., 1888, p. 35.

[3] Repert. für die Pharm. 13, pp. 446-457 (1822).

[4] Ann. Chim. et Phys. Ser. 2, 21, pp. 53-56 (1822).

[5] 3d edition, I, p. 10 (1893).

[6] C. L. Bloxam states equal parts by weight of arsenic and copper acetate. (See Chemistry, 9th edition, p. 271 (1907).)

[7] From correspondence on file.

allowed to stand two hours, then well stirred, after half an hour stirred again, and finally at the end of a quarter of an hour the liquid is drawn off and filtered. The resulting Paris green is dried on racks for four or five days at 185° F., or in a steam vacuum oven about 260° F. The yield is 985 pounds.

An electrolytic process for making Paris green from metallic copper, arsenous oxide and acetic acid was patented by Richard Franchot in 1902. No information relative to the character of the product is available.

Paris green is a copper aceto-arsenite for which Eugène Ehrmann's formula [1] is generally accepted.

$$Cu(C_2H_3O_2)_2 \cdot 3\,Cu(AsO_2)_2.$$

As a double salt it may be said to consist of 1 part of copper acetate to 3 of copper metarsenite, equivalent to 17.91 per cent. of the former to 82.09 per cent. of the latter. The structure of Paris green and its homologues was carefully studied by Avery, and while his results [2] most frequently approached a ratio of 1 :3, there was invariably a deficiency in arsenic. As the product is not recrystallizable he recognized that purity must be assured largely by a microscopical examination, which proved a questionable guide for so unstable a compound.

Although some chemists claim that the formula is only empirical it certainly expresses the proportion of cupric oxide to combined arsenic trioxide as found in well-formed greens. Four hundred and ninety-nine samples [3] collected in the open market by the Pennsylvania department of agriculture contained on the average: —

	Per Cent.
Cupric oxide,	29.41
Total arsenic trioxide,	56.56
Water soluble arsenic,	1.41

The relation of cupric oxide to "insoluble" arsenous oxide is 1 :1.875, theory 1 :1.865. Similar results are reported by others.

The comparatively high specific gravity of Paris green, as

[1] Bul. Soc.: ind., Mulhausen 7, pp. 68-80 (1834).
[2] Jour. Amer. Chem. Soc., 28, p. 1155 (1906).
[3] J. W. Kellogg, Bul. No. 192, p. 37 (1910).

recorded by Miles [1] and by Fernald [2] of 3.29 and 3.42 respectively, results in a low power of suspension as shown by Colby [3] of five minutes for a coarse sample and seventeen minutes for a fine, in 1 foot column of water at the proportion ordinarily applied. Woods and Hanson [4] show as a result of a microscopical examination of 21 commercial samples of Paris green, slow process with possibly one exception, that on the average only 5.27 per cent. of the green particles exceeded a diameter of 19.2 microns (.00077 of an inch). The ammonia test for purity mentioned by Riley [5] and by Paddock [6] is now considered of little value except in determining the presence of insoluble materials such as flour and gypsum added as a filler.

The presence of free arsenic in Paris green in any appreciable amount is deemed objectionable by all investigators on account of possible injury to the foliage due to its corrosive action. While free arsenic can usually be detected by the microscope, its quantitative determination for a time proved a more difficult matter, and results by the earlier methods were of questionable value except in a comparative sense. Haywood [7] found that Paris green continued to yield arsenic to successive portions of warm water at 50° to 60° C., and also to repeated washings of cold water on a filter. He secured practically constant results by treating 1 gram of green in a flask with 500 cubic centimeters of water for twelve days, but subsequent tests [8] showed the presence of soluble copper, indicating either solution or breaking down of the green. He favored the latter view, but assumed that the decomposition was in proportion to original content and corrected the results accordingly.

Hilgard [9] acknowledged that warm water was not permissible and recommended a treatment conforming more nearly to orchard practice, 1 gram to 1,000 cubic centimeters of cold water for twenty-four hours with prolonged agitation. He questioned any dissociation of the green, but admitted that continued

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[1] Va. Exp. Sta., Bul. No. 24, p. 16 (1893).
[2] Mass. Bd. Agr. Rept., 45, p. 355 (1898).
[3] Cal. Exp. Sta., Bul. No. 151, p. 34 (1903).
[4] Me. Exp. Sta., Bul. No. 154, p. 114 (1908).
[5] U. S. Ent. Com., Bul. No. 3, p. 56 (1880).
[6] N. Y. Exp. Sta., Bul. No. 121, p. 219 (1897).
[7] Jour. Amer. Chem. Soc., 22, p. 579 (1900).
[8] Jour. Amer. Chem. Soc., 22, p. 705 (1900).
[9] Jour. Amer. Chem. Soc., 22, p. 691 (1900).

percolation gave free arsenic. Avery and Beans,[1] working with a sample of perfect structure and of nearly theoretical composition, found that when treated in a stoppered flask, ½ gram to 500 cubic centimeters of water, the arsenic continued to pass into solution for sixteen weeks, the duration of the experiment. Upon breaking the granules of Paris green by grinding in a mortar the disintegration was more rapid until a state of equilibrium was reached. Carbonic acid also increased the solubility of the arsenic. The decomposition was evidently due to hydrolysis, as the arsenic dissolved in much greater proportion of the original content than did the copper. They concluded that any method based on solubility in water was merely arbitrary, as "the amount of arsenic trioxide in solution appears to depend almost entirely on the length of time of action, the concentration of the solution and the state of division of the particles of Paris green." To distinguish free arsenic from that rendered free by hydrolysis, Avery and Beans recommended boiling 1 gram of green five minutes in 25 cubic centimeters of sodium acetate solution (1 to 2). It was found that the sodium acetate solution readily dissolved the free arsenic and at the same time largely prevented hydrolysis of the green. The Hilgard method, 1 gram to 1,000 cubic centimeters of water for twenty-four hours with agitation, indicates free and loosely combined arsenic, and while such results are invariably higher than the former, the increase for greens of perfect structure, free from broken particles, is comparatively slight. These two processes are now quite generally employed. The Association of Official Agricultural Chemists [2] recognizes the acetate method and the ten days' extraction method recommended by Haywood as provisional methods.

To prevent arsenical injury to foliage, Gillette [3] and Kilgore [4] advised mixing Paris green with milk of lime to neutralize the free arsenic, and Weed [5] suggested combining the green with Bordeaux mixture.

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[1] Jour. Amer. Chem. Soc., 23, p. 111 (1901).

[2] Methods of Analysis Bur. Chem. Bul. No. 107 (revised), p. 27 (1908).

[3] Iowa. Exp Sta., Bul. No. 10, pp. 410–413 (1890).

[4] N. Car. Exp. Sta., Bul. No. 77b, pp. 4–7 (1891).

[5] Ohio Exp. Sta., Bul. (Vol. 2) No. 7, p. 186 (1889); *Ibid.*, (Vol. 4) No. 2, pp. 39–42 (1891).

Experimental Results.

The terms "instantaneous" and "slow process" are used to designate Paris greens of different physical structure. While this classification may not be in strict conformity with some writers it appears, nevertheless, the most desirable for the purpose intended.

Instantaneous green is the result of a quick boiling process as previously shown. The ultimate reaction is illustrated by the following equation: —

$$3\,As_2O_3 + 4\,Cu(C_2H_3O_2)_2H_2O$$
$$= Cu(C_2H_3O_2)_2 \cdot 3\,Cu(AsO_2)_2 + 6\,C_2H_4O_2 + H_2O.$$

If the process could be carried out with the ingredients in the proportion given there would be very little waste. In practice, however, instead of 1 part by weight of arsenous acid to 1.34 parts of copper acetate, an equal amount appears necessary to insure the desired change. This is probably due to the weak acid properties of the arsenic.

Slow process green is generally formed less rapidly and at a lower temperature than the instantaneous. From what could be learned the slow process seems to be the one employed by most of the large manufacturers. Blue vitriol is used as the source of copper, and sodium arsenite ($NaAsO_2$) in place of arsenous oxide, on account of its greater solubility and the necessity for a base to neutralize the sulfuric acid. Sodium arsenite is easily prepared by adding a thin paste of arsenous oxide in slight excess to a boiling solution of caustic soda or of a carbonate.

$$Na_2CO_3 + As_2O_3 = 2\,NaAsO_2 + CO_2.$$

The soda and arsenic readily combine with volatilization of carbonic acid. As commercial salts were often employed in our work the analyses of two are given: —

Sodium Arsenite.

	Baker and Adamson (Per Cent.).	Kahlbaum (Per Cent.).	Theoretical (Per Cent.).
Arsenic trioxide,	78.68	74.71	76.15
Sodium oxide,	18.45	22.63	23.85
	97.13	97.34	100.00

The sodium oxide was calculated from the alkalinity, determined by direct titration with methyl orange as indicator, a process sufficiently accurate for the purpose of checking quality.

The several reactions taking place in the manufacture of slow process green may be summarized in a single equation: —

$$4\ CuSO_4 5\ H_2O + 8\ NaAsO_2 + 2\ C_2H_4O_2$$
$$= Cu(C_2H_3O_2)_2 \cdot 3\ Cu(AsO_2)_2 + As_2O_3 + 4\ Na_2SO_4 + 6\ H_2O.$$

Sodium arsenite reacts upon the blue vitriol with the production of a bulky, yellowish-green precipitate of copper arsenite (Scheele's green), which in turn is acted upon by the acetic acid with the formation of a greatly reduced volume of Paris green. Experience has shown, as indicated by the above formula, that about $\frac{1}{3}$ more arsenic is required for the production of the green than actually enters combination, as was the case with the instantaneous process. Acetic acid in excess of the 2 molecules stated (by nearly 66 per cent.) is needed for the reaction. It is evident from what has been said that the manufacture of slow process green requires considerable equipment, expensive reagents and expert control which, together with the unavoidable waste of chemicals, insures a costly product.

The two general processes for making Paris green and their several reactions were carefully studied in the station laboratory to ascertain the character of the product that might reasonably be expected. As a result of numerous experiments a combination process, using copper acetate and sodium arsenite, together with sufficient acetic acid to offset the alkalinity of the arsenite, was found the most acceptable.

$$4\ Cu(C_2H_3O_2)_2H_2O + 6\ NaAsO_2 + 6\ C_2H_4O_2$$
$$= Cu(C_2H_3O_2)_2 \cdot 3\ Cu(AsO_2)_2 + 6\ NaC_2H_3O_2.$$

The reaction was easy to control, could be carried out at any temperature from that of the laboratory to boiling and gave a product of variable physical structure and of fine color. Solutions of different concentrations were tried, of which $\frac{1}{5}$ molecular (M/5) for the acetate and $\frac{1}{2}$ molecular (M/2) for the arsenite proved satisfactory. This process appeared to require less arsenic in *excess* than the ordinary method, although the

work was performed on too small a scale to warrant positive statements to that effect.

Attention has already been called, on pages 180 and 181 to two samples of Paris green supplied by different manufacturers for the investigation, of which the second was employed in actual spraying tests. The sample of instantaneous green was made according to the method described, with the exception that crystallized copper acetate was substituted for verdigris. The slow process sample was selected from a factory run of commercial green manufactured substantially as has been stated.

Paris Green from Chemical Manufacturers.

	Instantaneous Green.	Slow Process Green.	Theoretical.
Manufacturer,	A	B	–
Character of product,	Dry powder.	Dry powder.	–
Color,	Pale green.	Bright green.	–
Shape of green particles,[1]	Irregular, angular.	Mostly perfect spheres.	–
Size of green particles,[1]	Average 10 μ.	12–30 μ, average 17.39 μ.	–
Uniformity,[1]	Very little variation.	Considerable variation.	–
Nature of impurities,[1]	Crystalline matter.	Crystalline matter.	–
Amount of impurities,[1]	Large amount.	Small amount, less than 5 per cent.	–
Flow,	Poor.	Excellent.	–
Film test,	Whitish.	Green.	–
Water (per cent.),	.78	1.46	–
Cupric oxide (CuO) (per cent.),	31.74	30.94	31.39
Arsenic trioxide (As_2O_3) (per cent.),	56 91	56.34	58.55
Acetic anhydride ($C_4H_6O_3$) (per cent.),	10.37	9.94	10.06
Ferric (Fe_2O_3) and aluminum oxides (Al_2O_3) (per cent.).	–	.53	–
Sulfuric acid (SO_3) (per cent.),	–	.29	–
Insoluble matter (per cent.),	.00	.05	–
	99.83	99.55	100.00
Arsenic (As) (per cent.),	43.13	42.68	44.35
Suspension in water,	–	17 minutes.	–
Suspension in filtered lime water,	–	48 minutes.	–

Both greens contained an excess of cupric oxide and acetic acid, and may have been hydrolyzed somewhat by washing with

[1] Determined by the entomological department of this station.

the formation of a basic acetate. Sample B showed a considerable amount of impurities. Any hypothetical combination of the various constituents that might be offered would be decidedly arbitrary, and a discussion seems inadvisable at this time. A careful study of the results would indicate that the slow process green, exclusive of moisture, was at least 96 per cent. pure. To be of standard quality Paris green should contain not less than 50 per cent. of arsenous oxide combined with copper, and not more than 3.50 per cent. of arsenous oxide soluble in water. The poisonous character of Paris green is dependent on the arsenic content, but the form in which the arsenic exists largely fixes its value as an insecticide. Adulteration is seldom practiced under the inspection laws now in force.

Paris green is a dry, impalpable powder that readily passes a 100-mesh sieve, and to the touch resembles flour. A microscopical examination is required to determine the size, shape and uniformity of particles as well as the general character and amount of impurities. The latter may consist of Scheele's green that was not transformed or by-products such as arsenic, sodium sulfate, sodium acetate and possibly other compounds not intentionally added but present in the original chemicals. The sample of instantaneous green under examination was of a pale green color, and consisted of very small, irregular, angular particles with considerable impurity. It was cohesive, had a poor "flow," and the film test [1] on glass appeared whitish. The slow process green, on the other hand, had a brilliant green color of metallic luster, and was composed of minute green spheres of various sizes, together with a small amount of crystalline and fragmentary matter. It had an excellent "flow," and the film test on glass was green. The size of the particles is affected by the concentration, temperature and amount of agitation at the time of formation. The smaller the globules with retention of perfect form and similar size, the more desirable the product.

Paris green has a high specific gravity and a low power of suspension. In the station laboratory suspension was determined [2] in a foot column containing the insecticide at the proportion of 1 gram of dry salt to 1,000 cubic centimeters of

[1] C. W. Woodworth, Cal. Exp. Sta., Bul. No. 126, p. 13 (1899).

[2] Modification of the California method. G. E. Colby, Cal. Exp. Sta., Bul. No. 151, pp. 33-35 (1903).

water. The mixture in a closed cylinder was thoroughly agitated, and the reading, in minutes, taken with a horizontal microscope, using a 1-inch eyepiece and ½-inch objective, when movement of the particles midway of the column (6 inches down) was no longer apparent. The slow process green gave a reading of seventeen minutes in water and forty-eight minutes in filtered lime water. As lime tends to flocculate the particles of Paris green, the test should be performed immediately after mixing.

Although copper aceto-arsenite is termed insoluble in water, decomposition readily takes place under certain conditions; therefore, the determination of so-called "free" and "loosely combined" arsenic is closely related to stability of product and should be considered in that connection.

Solubility.

	Instantaneous Green.	Slow Process Green.
Manufacturer,	A	B
Water (per cent.),	.78	1 46
Sodium acetate soluble "free arsenic" (Avery and Beans Method): —		
Cupric oxide,	Trace.	Trace.
Arsenic trioxide (per cent.),	1.45	.74
Copper acetate soluble: —		
Arsenic trioxide (per cent.),	1.09	.45
Water soluble "free and loosely combined arsenic" (Hilgard Method):—		
Cupric oxide,	None.	Trace.
Arsenic trioxide, (per cent.)	2.06	.86
Solids (per cent.),	3.08	1.96
Lime water soluble: —		
Cupric oxide,	None.	–
Arsenic trioxide (per cent.),	.97	1.52
Ammonia insoluble (per cent.),	–	.11

Neither of the greens contained an excessive amount of free or of free and loosely combined arsenic, judging by the standard, although the slow process was decidedly the better in that respect. This was to be expected, as the finely divided angular particles of the instantaneous green offered greater surface and apparently less resistance to a solvent than the nearly perfect

spheres of the slow process. The copper acetate soluble results are of uncertain value. Filtered lime water, with .12 per cent. calcium oxide, contained insufficient lime to prevent solution of the arsenic. Ammonia dissolves Paris green and the normal by-products concomitant with its manufacture, such as copper arsenite, arsenous oxide, sodium sulfate and sodium acetate; the residue, .11 per cent. in case of the slow process green, was organic and other insoluble materials.

To ascertain the solvent action of various substances in solution on Paris green, a series of tests were conducted with the slow process sample. The green in stoppered flasks was treated with water and with solutions of the respective compounds at the rate of 1 gram to 1,000 cubic centimeters for twenty-four hours at laboratory temperature, with occasional agitation during the working day.

Solubility Tests, Slow Process Green.

Solvent.	Amount of Solvent in a Liter of Water (Grams).	Soluble As_2O_3 (Per Cent.).	Copper.	Remarks.
Distilled water,	-	.84	None.	- -
Water saturated with CO_2,	-[1]	6.16	Much.	- -
Ammonium hydroxide (concentrated).	1	.86	None.	- -
Ammonium hydroxide (concentrated).	5	13.49	Much.	Residue darker green.
Ammonium carbonate,	1	6.83	Much.	Blue solution.
Ammonium carbonate,	5	55.93	Excessive.	Blue, nearly complete solution.
Ammonium chloride,	1	2.41	Considerable.	- -
Ammonium nitrate,	1	2.03	Trace.	- -
Ammonium nitrate,	5	4.70	Much.	- -
Ammonium nitrite solution,	1	.36	- -	- -
Ammonium nitrite solution,	5	.36	- -	- -
Ammonium sulfate,	1	4.20	Considerable.	- -
Sodium carbonate (anhydrous),	1	3.15	None.	- -
Sodium bicarbonate,	1	.84	Very slight trace.	- -
Sodium chloride,	1	.96	None.	- -
Sodium nitrate,	1	.86	None.	- -
Sodium nitrite,	1	.88	- -	- -
Sodium sulfate (anhydrous),	1	1.67	Very slight trace.	- -
Boiling water, one hour,	-	14.93	Much.	Change in color of residue.

[1] About 5 gallons of gas used, water pressure.

Cold water dissolved a small amount of arsenic, boiling water very much more. The green appeared to resist hot water for a considerable time after which the change was noticeable. If the boiling had been continued all the arsenic would probably have passed into solution. The .10 per cent. ammonium salts, exclusive of nitrite, dissolved on the average 58 per cent.[1] more arsenic than the corresponding sodium salts. In both instances the carbonate was the most active, followed respectively by the sulfate, chloride and nitrate. Sodium bicarbonate was apparently inactive under the conditions employed. Free carbonic acid was effective and so was ammonia when in sufficient amount to overcome the resistance of the green, and jointly, carbonic acid and ammonia dissolved the most arsenic.

It is evident from what has been stated that carbonic acid and ammonia of the atmosphere in conjunction with dew, fogs or light rains and high temperature will materially increase the dissociation of Paris green. Data more or less contradictory have been offered by various investigators relative to the influence of weather conditions on the effect of arsenic on foliage. While more or less problematical, certain deductions seem warranted: conditions favoring a rapid drying of the green and its continuance in a dry state are propitious. For instance, a relatively high temperature, low humidity and a good circulation of air at the time of application, followed by warm, dry weather should tend toward a minimum of arsenical injury. On the other hand, factors conducive to solubility of the arsenic and its passage by osmosis into the substance of the leaf are detrimental; as, for example, warm, "muggy" weather or warm weather accompanied by fogs or heavy dews. Rains are not necessarily injurious if of sufficient quantity to remove the soluble arsenic from its sphere of influence. The addition of milk of lime to Paris green tends to reduce arsenical injury by forming, with the free arsenic, arsenite of lime insoluble in the presence of excess lime. As lime flocculates the particles of green, it is not advisable to prepare the spray mixture until shortly before application.

In conclusion, it may be said that Paris green contains a fairly high per cent. of arsenic, is nominally insoluble in water

[1] Direct comparison.

but unstable, hydrolizing readily under favorable conditions. It has a low power of suspension though its fineness permits of reasonable distribution. It is a poor indicator without lime of the leaf surface covered, but possesses fair adhesive qualities.

B. Calcium Arsenite.

Historical.

Early attempts to use arsenous oxide as an insecticide by Riley [1] in 1869 and Saunders and Reed [2] in 1871 were unsatisfactory. John Smith [3] in 1868 appears to have been more successful, applying it in water, but the practice proved too hazardous to warrant its continuance, although freshly prepared mixtures have been applied in numerous instances without injury. The relatively high cost of Paris green and London purple, and the necessity of adding lime to neutralize the free arsenic, led to the production of lime arsenite. So far as known this has always been a farm preparation and not a commercial product.

Kilgore [4] recommended adding 1 pound of white arsenic to 2 pounds of lime in 2 to 5 gallons of water and boiling thirty minutes. Taft [5] advised adding 2 pounds of freshly slaked lime to 1 pound of arsenic in 2 gallons of water and boiling forty minutes. Kedzie [6] suggested dissolving the arsenic in a solution of sal soda and offered the formula which bears his name. Boil 2 pounds of arsenic with 8 pounds of sal soda in 2 gallons of water until dissolved. Slake 2 pounds of lime, add to 40 gallons of water and stir in 1 pint of the arsenic solution. Stewart [7] evidently noted the undue amount of sal soda in the Kedzie formula and reported better results, using equal parts, 2 pounds of arsenic and 2 pounds of sal soda. E. L. Smith [8] recommended 2 pints of Kedzie mixture to 6 to 10 pounds of lime in 50 gallons of water, and claimed that the additional lime increased safety and adhesiveness.

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[1] Potato Pests, p. 60 (1876).

[2] Can. Ent., 3, pp. 45–47 (1871).

[3] Western Pomologist, 2, p. 125 (1871). Cited by Lodeman.

[4] N. Car. Exp. Sta., Bul. No. 77b, pp. 7–8 (1891).

[5] Mich. Bd. Agr. Rept., 35, p. 119 (1897). In Rept. 37, p. 466 (1899), the amount of lime was increased 8 pounds on application.

[6] Mich. Farmer, 31, p. 132 (1897).

[7] Penn. Exp. Sta., Bul. No. 99, p. 11 (1910).

[8] Cal. Exp. Sta., Bul. No. 126, p. 24 (1899).

Authorities differ as to the arsenite that results from the union of lime and arsenic. Prescott and Johnson [1] state that the arsenites of the alkaline earth are usually ortho compounds, Merck & Co.[2] and Gooch and Walker [3] give neutral orthoarsenite of lime, while Comey [4] and Watts' Dictionary [5] recognize the ortho, $Ca_3(AsO_3)_2$, the meta, $Ca(AsO_2)_2$, and the pyro, $Ca_2As_2O_5$, salts. The latter is designated a mixture of basic salts with 1 molecule of water, $2CaO.As_2O_3.H_2O$. So far as noted the formula acknowledged by experiment station workers has been that of the neutral ortho salt, although the subject has been given little attention.

As determined by Colby [6] the suspension, in 1 foot column, of arsenite of lime made according to directions published by Taft was forty-four minutes, and by Kedzie formula fifty-seven minutes. Headden [7] noted that arsenite of lime was almost entirely soluble in water and in dilute solutions of sodium sulfate and sodium chloride.

Experimental Results.

For the preparation of a high-grade arsenite of lime required for the work in view, precipitation from soluble salts of lime and of arsenic, while more costly, promised a more definite and uniform product. As lime arsenite is noncrystallizable, precipitation from perfect solutions insured better combination and greater freedom from admixtures. The comparative insolubility of lime, CaO, necessitated the use of a soluble salt. Lime salts of strong oxidizing acids were deemed objectionable on account of possible action on the arsenite and were excluded. The acetate of organic compounds and the chloride of the halogens were selected for trial, but after several tests the chloride was considered preferable. The fused salt was almost invariably employed. It should be free from other bases forming insoluble compounds with arsenic. The direct use of arsenous oxide is not advisable with a lime *salt*, not only for

[1] Qual. Chem. Anal., 6th edition, p. 57 (1905).
[2] Merck's 1907 Index, p. 113.
[3] Outlines of Inorg. Chem. Pt. 2, p. 184 (1905).
[4] Dict. of Chem. Sol., p. 41 (1896).
[5] Watts' Dict. of Chem., 3d edition, 1, p. 306 (1893).
[6] Cal. Exp. Sta., Bul. No. 151, p. 34 (1903).
[7] Col. Exp. Sta., Bul. No. 131, p. 22 (1908).

the reason that ordinary porcelaneous arsenic in pulverulent condition is difficult to moisten and of low solubility, but more particularly because it would induce a secondary reaction from lack of base to satisfy the acid that was previously combined with the lime. Sodium arsenite, $NaAsO_2$, is readily soluble and proved a satisfactory source of arsenic. A salt of fair quality can be procured on the market, or is easily prepared by adding 1 part of arsenous oxide to a boiling solution of 1.45 parts of sal soda, or an equivalent amount of soda in the form of anhydrous carbonate, bicarbonate or hydroxide. A slight excess of arsenic is required to insure complete volatilization of the carbonic acid.

$$Na_2CO_3 \cdot 10\,H_2O + As_2O_3 = 2\,NaAsO_2 + CO_2 + 10\,H_2O.$$

The resulting arsenite should be free from arsenates, carbonates, sulfates or other acids forming insoluble compounds with lime.

Any decision as to concentration of solutions is naturally more or less arbitrary; dilution tends to make difficult precipitation with considerable loss of salt, and the opposite an unwieldy precipitate with greater occlusion. As a compromise solutions of ½ molecular strength (M/2) were finally adopted. Another factor studied was the influence of temperature of solutions on the resulting precipitate, ranging from that of the laboratory to nearly boiling point at the moment of precipitation. Room temperature with two hours' standing gave a product of practically the same composition, and of probably better physical characteristics, than the higher temperatures and was considered more desirable.

As the alkalinity of the soda in sodium arsenite is not destroyed by the arsenous acid, it should be run into the calcium chloride solution slowly with constant agitation in order to prevent any precipitation of calcium hydroxide. An excess (10 per cent.) of sodium arsenite was found desirable to perfect the salt. After standing several hours the liquor was removed by means of a Buchner funnel, and the lime arsenite washed rapidly with cold water until nearly free from chlorides. A centrifuge or filter press might give equally good or better results provided the work was done rapidly. Undue washing was avoided, as it was thought safer to retain a small amount

of sodium chloride than to take chances on *possible* hydrolysis and decomposition of the arsenite, an action readily inferred from the behavior of Paris green under similar conditions. The above method of preparation was employed in all subsequent work unless otherwise noted. Minor changes were attempted in some instances from which no apparent benefit was derived.

As previously stated there was considerable uncertainty as to the composition of the lime precipitate. To ascertain whether the resulting product was a definite compound and, if so, its composition, salts were produced from an excess of sodium arsenite into calcium chloride and *vice versa*, observing the usual precautions as to dilution, precipitation of calcium hydroxide, oxidation of the arsenic, etc. Incomplete analyses of a few laboratory samples are given.

Calcium Arsenite produced in the Laboratory (Per Cent.).

	Excess $NaAsO_2$ into $CaCl_2$.			Excess $CaCl_2$ into $NaAsO_2$.
	Precipitated Hot.	Precipitated at 90° C.	Precipitated and held at 90° C. for Two Hours.	Precipitated Hot.
Water,	.12	.12	–	.12
Arsenic trioxide,	77.01	77.01	76.75	76.80
Insoluble matter,	–	–	–	.03

The small samples were of uniform composition, indicating a definite compound of about 77 per cent. arsenic content. This amount of arsenic exceeds the requirements of the ortho and pyro salts, and substantially conforms to that of the meta compound with a theoretical content of 77.92 per cent. The following equation illustrates the reaction that must have occurred: —

$$CaCl_2 + 2\,NaAsO_2 = Ca(AsO_2)_2 + 2\,NaCl.$$

Attention has been called on pages 180, 181 and 182 to 5 samples of lime arsenite supplied by several firms for the investigation. Manufacturer C was furnished directions deduced from experimental work in the station laboratory. A and B evidently employed a different method.

Calcium Arsenite from Chemical Manufacturers.

	As received.					In Dry Matter.	Theoretical.
Manufacturer,	A	B	C_1	C_2	C_3	C_3	–
Character of product,	Dry, granular.	Moist powder.	Dry, granular.	Gritty [2] paste.	Smooth paste.	–	–
Color,	White.	White.	Slightly pink.	Pink. [2]	Nearly white.	–	–
Water (per cent.),	.67	16.27	.80	–	67.87	–	–
Calcium oxide (CaO) (per cent.),	–	–	21.63	–	6.78	21.10	22.08
Arsenic trioxide (As_2O_3) (per cent.),	29.39	29.36	76.31	–	23.87	74.28	77.92
Arsenic pentoxide (As_2O_5) (per cent.),	–	–	–	–	.09	.28	–
Magnesium oxide (MgO) (per cent.),	–	–	–	–	.05	.16	–
Chlorine (Cl) (per cent.),	–	–	–	–	.80	2.49	–
Sodium oxide (estimated) (Na_2O) (per cent.),	–	–	–	–	.70	2.18	–
Insoluble matter (per cent.),	5.63	.20	.02	–	.01	.03	–
	–	–	–	–	100.17	100.52	100.00
Less oxygen equivalent to chlorine (per cent.),	–	–	–	–	.18	.56	–
	–	–	–	–	99.99	99.96	–
Arsenic (As) (per cent.),	–	–	–	–	18.14	56.46	59.02
Suspension in lime water, hours,	–	–	–	–	56	–	–
Suspension in lime water after drying, hours,	–	–	–	–	48	–	–

[1] A, B and C refer to individual manufacturers, the numerals to different samples.
[2] Gritty on account of compressed air being used to agitate and pink due to the presence of manganese.

Sample C_1 and C_3 confirmed the former analyses as to arsenous oxide, and the molecular ratio of calcium oxide to arsenous oxide was almost theoretical for calcium metarsenite. It would, therefore, appear safe to assume that lime arsenite precipitated from soluble salts of lime and of arsenic is invariably the meta salt.

Sample C_3 was employed in spraying, although in the process of manufacture it had been imperfectly washed, contained a small amount of magnesia and showed a slight oxidation of arsenic. Any arrangement of constituents is of doubtful value; still, the following may be suggested: —

Calcium Arsenite employed in Spraying.

Manufacturer,	C_3
Water (per cent.).	67.87
Calcium orthoarsenate ($Ca_3(AsO_4)_2 \cdot 3\,H_2O$) (per cent.),	.18
Magnesium metarsenite ($Mg(AsO_2)_2$) (per cent.),	.30
Calcium metarsenite ($Ca(AsO_2)_2$) (per cent.),	30.31
Sodium chloride (NaCl) (per cent.),	1.32
Insoluble matter (per cent.),	.01
	99.99

The above analysis would indicate a purity, on a water-free basis, of 94.34 per cent.

Calcium metarsenite, prepared according to the directions given, is a smooth white gelatinous mass or jell of very fine, adhesive particles. The power of suspension which has to be determined in lime water to prevent partial solution is extremely high but lessened by drying. Sample C_3 gave phenomenal results, though the actual figures are indicative rather than absolute. A moist paste of arsenite of lime proved unstable, gradually changing to arsenate with the separation of free arsenic (As). Calcium arsenite is probably the most soluble arsenical insecticide in use as shown by the following results: —

Solubility.

Manufacturer,	A	B	C_1	C_2	C_3
Water (per cent.),	.67	–	.80	–	67.87
Calcium acetate soluble: —					
Arsenic trioxide (per cent.),	27.55	–	11.62	–	–
Water soluble (Hilgard Method): —					
Calcium oxide (per cent.),	–	–	10.98	–	3.14
Arsenic trioxide (per cent.),	24.78	–	40.88	–	11.58
Solids (per cent.),	64.90	–	53.48[1]	–	16.54
Lime water soluble: —					
Arsenic trioxide (per cent.),	.14	–	.17	–	.05

The calcium acetate soluble appeared to have no particular significance, and the test was eventually dropped. The water soluble results are only approximate, as slight variations in temperature or agitation caused marked differences. Solubility is apparently not a result of hydrolysis, as proportionally the lime passed into solution almost as rapidly as the arsenic. If hydrolysis played any part it would seem to be inappreciable. Lime arsenite was nearly insoluble in lime water. In order to secure additional data relative to the solubility of lime arsenite, 1 gram of sample C_3, after drying, was subjected to the action of various solvents for twenty-four hours in stoppered flasks with occasional agitation, the results of which are stated below: —

Solubility Tests, Sample C_3 Dried.

Solvent.	Amount of Solvent in a Liter of Water (Grams).	Soluble As_2O_3 (Per Cent.).	Lime.	Remarks.
Distilled water,	–	38.45	Present.	–
Water saturated with CO_2,	–[2]	62.22	Present.	–
Ammonium hydroxide (concentrated),	1	36.66	Present.	–
Ammonium carbonate,	1	64.36	Trace.	–
Ammonium chloride,	1	53.40	Present.	–
Ammonium nitrate,	1	51.97	Present.	–
Ammonium nitrite solution,	1	43.06	Present.	–
Ammonium sulfate,	1	52.71	Present.	–
Sodium carbonate (anhydrous),	1	59.32	None.	–
Sodium bicarbonate,	1	62.19	None.	–
Sodium chloride,	1	41.20	Present.	–
Sodium nitrate,	1	40.53	Present.	–
Sodium nitrite,	1	40.72	Present.	–
Sodium sulfate (anhydrous),	1	41.08	Present.	–
Boiling water, 1 hour,	–	58.63	Much.	–

[1] Contained .39 per cent. of ferric and aluminum oxides and .08 per cent. of magnesium oxide.

[2] About 5 gallons of gas used, water pressure.

Calcium metarsenite was fairly soluble in cold water, but much more so in boiling water. The ammonium salts, exclusive of nitrite, dissolved about 19 per cent.[1] more arsenic than the corresponding sodium salts. The carbonate in both instances proved very effective, followed by the chloride, sulfate and nitrate with only slight differences between the latter. An interchange of bases must have resulted in many instances to permit the high solubility recorded. Carbonic acid, combined and free, was the most active of any single agent, consequently excess lime should afford one of the best methods of protection under atmospheric conditions. Ammonium hydroxide depressed slightly the solubility of the arsenic.

Calcium metarsenite contains the highest per cent. of arsenic of all the common insecticides, and is quite soluble except in presence of excess lime; the fineness of its particles and the high power of suspension insure uniform distribution; the white film readily indicates the surface covered; and its adhesiveness provides protection for a reasonable period under average weather conditions.

C. Lead Arsenates.

Historical.

F. C. Moulton,[2] chemist for the Massachusetts Gypsy Moth Commission, was the first to prepare arsenate of lead for insecticidal purposes. He employed lead acetate and sodium arsenate. The work was continued by F. J. Smith,[3] who studied the composition of the chemicals used, the reactions and other matters pertaining to the manufacture. He stated that ordinary spray material was not a single salt, but a mixture of neutral and acid arsenates, and believed that the relative amount of each depended principally upon the source of the soluble lead salt, although temperature and concentration at the moment of precipitation affected the results; in other words, that acetate of lead had a tendency, other factors being equal, to yield the neutral salt and the nitrate the acid arsenate.

An electrolytic process for making arsenate of lead was patented by C. D. Vreeland in 1907, using lead, sodium arsenate

[1] Direct comparison.

[2] Mass. Bd. Agr. Rept., 41, p. 282 (1894).

[3] *Ibid.*, 45, pp. 357–371 (1898).

and an electrolyte of sodium nitrate. Patents have also been taken out on various other methods of manufacture, references to which are found in technical journals. I. W. Drummond patented a dry preparation of lead nitrate, sodium arsenate and corn starch to be mixed with water when applied.

Most authorities recognize neutral orthoarsenate of lead, $Pb_3(AsO_4)_2$, and acid arsenate, $PbHAsO_4$, and a few mention pyroarsenate, $Pb_2As_2O_7$. W. H. Volck [1] claims the latter salt may occur in commercial pastes, though Lefevre [2] states that it is decomposed by cold water. Pyroarsenate differs from 2 molecules of the acid salt by 1 molecule of water.

$$Pb_2As_2O_7 + H_2O = 2\,PbHAsO_4.$$

So far as noted, the presence of pyroarsenate in insecticides has not been proved.

The low specific gravity of lead arsenate, 1.00668 according to Smith [3] (salt not specified), results in a high power of suspension as shown by Colby,[4] from nitrate one hundred and thirty minutes and from acetate two hundred and forty minutes. Investigators have found lead arsenates comparatively little affected by hot water or carbonic acid. Dilute solutions of sodium carbonate, sodium chloride and sodium sulfate have an appreciable action as shown by Headden [5] and others. The acid salt has invariably proved the more unstable. Volck [6] noted that under alkaline conditions it tends to decompose with the formation of the ortho salt and arsenic acid, and he states that this reaction appears to take place in the orchards of the Pacific coast as a result of the continuous fogs and heavy dews. P. J. O'Gara [7] also claims that the acid salt is very injurious under certain climatic conditions. Haywood [8] recommended the addition of lime to arsenate of lead to prevent injury to delicate foliage.

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[1] Science, 33, p. 868 (1911).
[2] Cited by A. M. Comey, Dict. of Chem. Sol., p. 35.
[3] Mass. Bd. Agr. Rept., 45, p. 355 (1898).
[4] Cal. Exp. Sta., Bul. No. 151, p. 34 (1903).
[5] Col. Exp. Sta., Bul. No. 131, p. 22 (1908); Bul. No. 157, pp. 29, 30 (1910).
[6] *Loc. cit.*
[7] Science, 33, p. 900 (1911).
[8] Bur. Chem., Bul. No. 131, p. 49 (1910).

Experimental Results.

In the production of lead arsenates pure chemicals are a prime requisite for a high-grade product. The lead salts should be free from other bases forming insoluble arsenates, and the sodium arsenate ($Na_2HAsO_4 7H_2O$) from arsenites, carbonates, chlorides and sulfates. Acetate of lead is objectionable as a source of lead in that it readily carbonates on exposure to air. As to concentration of solutions, our experience has shown that for salts of such high molecular weight dilute solutions not exceeding ⅕ molecular (M/5) are preferable. At that dilution, laboratory temperature gives a very finely divided precipitate which is highly desirable from the standpoint of suspension. The arsenate should be run into the lead salt *very slowly* with thorough agitation in order to prevent precipitation of lead hydroxide due to the alkalinity of the sodium salt. The reverse precipitation, lead into the arsenic, proved less satisfactory both as to formation and behavior of the precipitate. While arsenic acid is stronger than arsenous, it neutralizes only about one-half the alkalinity of the soda in disodium hydrogen arsenate.

Neutral Lead Arsenate. — After many attempts, employing di and tri sodium and ammonium arsenates, salts containing arsenic and lead in proper molecular ratio were finally produced according to the following equation: —

$$3\,Pb(C_2H_3O_2)_2 3\,H_2O + 2\,Na_2HAsO_4 7\,H_2O$$
$$= Pb_3(AsO_4)_2 + 4\,NaC_2H_3O_2 3\,H_2O + 2\,C_2H_4O_2 + 11\,H_2O.$$

To obtain these results it was necessary to prepare the disodium arsenate in order to exclude carbonic acid which was present in the commercial salts purchased. The principal difficulties, however, arose from failure to add the strongly alkaline sodium arsenate slowly and with sufficient agitation to prevent the precipitation of lead hydroxide and to maintain an excess of at least 5 per cent. of lead to prevent the formation of the acid salt. The usual precautions as to concentration, temperature and thoroughness of washing were carefully observed. The following analyses of two samples show the material to be practically of theoretical composition: —

Neutral Lead Arsenate produced in the Laboratory.

Sample number,	31	32
Water 100° C. (per cent.),	.75	.70
Arsenic pentoxide (per cent.),	25.10	25.18
Lead oxide (per cent.),	73.15	73.20
Water occluded (per cent.),	.98	.82
	99.98	99.90

The lead salt invariably contained a small amount of water probably held by occlusion which is not volatilized at 100° C.

Acid lead arsenate is readily prepared from nitrate of lead and sodium arsenate provided dilute solutions are employed and the sodium salt added carefully in excess (10 per cent.).

$$Pb(NO_3)_2 + Na_2HAsO_4 7\ H_2O = PbHAsO_4 + 2\ NaNO_3 + 7\ H_2O.$$

By this method of procedure no difficulty was experienced in producing salts of theoretical composition. The acetate can be used as a source of lead, but is less satisfactory.

Six samples of lead arsenate were supplied by three manufacturers for the spraying tests. Manufacturer C was furnished full directions as outlined above for making the acid salt. The detailed process for preparing the neutral salt was not deduced until later.

Lead Arsenates from Chemical Manufacturers.

	Supplied as —								
	UNKNOWN.	NEUTRAL.			ACID.				
	–	–	–	Theoretical.	–	–	–	In Dry Matter.	Theoretical.
Manufacturer,[1]	A	B_1	C_1	–	B_2	C_2	C_3	C_3	–
Character of product,	Dry, granular.	Dry, powder.	Dry, slightly granular.	–	Dry, powder.	Dry, powder.	Smooth paste.	–	–
Color,	Yellowish.	Dirty white.	White.	–	White.	White.	White.	–	–
Water (per cent.),	–[2]	.34	6.39	–	.66	.35	46.99	–	–
Lead oxide (PbO) (per cent.),	–	66.11	69.74	74.43	63.63	65.39	34.58	65.23	64.28
Arsenic pentoxide (As_2O_5) (per cent.),	–	29.47	22.75	25.57	29.50	30.92	17.11	32.27	33.12
Water in combination (per cent.),	–	–	–	–	–	1.06	1.33	2.51	2.60
Chlorine (Cl) (per cent.),	–	–	–	–	–	–	.04	.08	–
Insoluble matter (per cent.),	–	.36	.01	–	.08	.00	.01	.02	–
	–	–	–	100.00	–	–	100.06	100.11	100.00
Less oxygen equivalent to chlorine (per cent.),	–	–	–	–	–	–	.01	.02	–
	–	–	–	–	–	–	100.05	100.09	–
Arsenic (As) (per cent.),	–	–	–	16.67	–	–	11.16	21.05	21.60
Suspension in water, minutes,	–	–	–	–	–	–	81	–	–
Suspension in water after drying, minutes,	–	–	–	–	–	–	42	–	–

[1] A, B and C refer to individual manufacturers, the numerals to different samples.

[2] Sample rejected.

Neutral and acid arsenates of lead are quite insoluble, although both salts will undoubtedly yield arsenic slowly to continuous percolation, the acid salt decomposing the more readily.

Solubility.

	Supplied as —					
	Neutral.			Acid.		
Manufacturer,	A	B_1	C_1	B_2	C_2	C_3
Water (per cent.),	–[1]	.34	6.39	.66	.35	46.99
Water soluble (Hilgard method): —						
Lead oxide (per cent.),	–	None.	.01	None.	.14	.06
Arsenic pentoxide (per cent.),	–	.48	.05	.16	.02	.03
Solids (per cent.),	–	2.33	1.13	4.21	2.10	.30

The acid salt C_3 was practically insoluble under the conditions tested, and nearly free from soluble by-products.

The legal standard[2] for commercial lead arsenate in form of paste specifies not more than 50 per cent. of water nor less than 12.50 per cent. of arsenic pentoxide and not more than .75 per cent. of arsenic pentoxide soluble in water. Sample C_3, acid salt, which was used in experimental work, exceeded standard requirements in all particulars. A careful study of the analytical results, C_3, might warrant the following combination: —

Acid Lead Arsenate employed in Spraying.

	Per Cent.
Water,	46.99
Acid lead arsenate ($PbHAsO_4$),	51.61
Lead chloride ($PbCl_2$),	.16
Lead hydroxide ($2PbO \cdot H_2O$),	1.34
Insoluble matter,	.01
	100.11

Exclusive of water, the purity was approximately 97.36 per cent. There was a small amount of lead chloride, but the most objectionable feature appeared to be the precipitated lead hydroxide due to careless preparation.

[1] Sample rejected.
[2] The insecticide act of 1910, section 7.

There is evidently a difference in stability between acid and neutral lead arsenates as measured by boiling ammoniacal solutions, but, contrary to general belief, it is apparently only a matter of degree. Both salts are decomposable, yielding soluble arsenic acid.

Neutral arsenate, sample 31, page 204, after being twice heated with ammonia and washed, gave a residue which was practically stable and tested as follows: —

	Per Cent.
Water,	.44
Arsenic pentoxide,	23.84
Lead oxide,	75.02
Occluded water,	.64
	99.94

Stability was apparently the result of a reversible reaction, ammonia setting arsenic acid free, and lead hydroxide, when present in sufficient excess (10 per cent.), completely reprecipitating it. Similar results were obtained by adding freshly precipitated lead hydroxide, litharge and lime to neutral arsenate, the excess base preventing the separation of arsenic acid.

If properly made, neutral and acid arsenates of lead are smooth, white pastes of very fine particles, low specific gravity, excellent suspension and exceptional adhesiveness. The power of suspension is injured by drying. The readings reported for sample C_3 are not the maximum, but were taken when no movement of particles was perceptible, although the mixture continued milky for a considerable period thereafter.

Both acid and neutral lead arsenates are slow-acting poisons of low arsenic content, and that in the form of pentoxide. They are practically insoluble in water and fairly stable. The fineness of the particles and low specific gravity insure a high power of suspension and uniform distribution. The white mixture readily indicates the leaf surface covered and dries to a film which adheres with great persistence.

THE NATURAL FERTILITY OF CRANBERRY BOGS.

BY F. W. MORSE, M.SC.

Years of experience by practical men have shown that cranberries are best grown on a peat bog the surface of which has been covered with a thin layer of sand. Furthermore, the best results with this soil are obtained only when there is an abundance of water by which at times the land may be flooded and at other times irrigated; and at the same time there must be opportunities for thoroughly draining the land at some stages of growth. This combination of peat subsoil, sandy surface and varying amounts of water is unusual in any other line of crop production, and most of the present methods pursued in cranberry culture are wholly empirical in their character.

One important problem now puzzling the cranberry grower is that of fertilization; is it necessary or unnecessary? The potential fertility of a true peat soil, that is, the amount of the elements of plant nutrition contained in its dry matter, is known to be high. Hopkins [1] states that a peat soil contains in the upper layer ($6\frac{2}{3}$ inches thick) of 1 acre, 35,000 pounds of nitrogen, 2,000 pounds of phosphorus and 2,900 pounds of potassium, while a layer 40 inches deep over 1 acre contains 197,000 pounds of nitrogen, 8,600 pounds of phosphorus and 21,400 pounds of potassium. He further states [2] that but little of this enormous store of material is in an actively available form, and estimates that a corn crop can get at not more than 7 pounds of potassium per acre, while in an experiment on a poorly drained field, corn was benefited by the addition of nitrogen.[3] The sand on the surface of the peat may be disregarded as a source of plant nutrients, but it is an important agent in making availa-

[1] Hopkins, C. G., Soil Fertility, Ginn & Co., 1910, pp. 83-87.

[2] *Ibid.*, p. 471.

[3] *Ibid.*, p. 472.

ble the elements contained in the peat. The water used in flooding and irrigating may be regarded in a similar way, since it is as pure as the average public water supply and often purer.

Analyses of the cranberries and cranberry vines reveal an unusually low proportion of nitrogen and ash constituents, especially in the fruit which, as a rule, is all that is removed from the bog.

TABLE I. — *Composition of Cranberries and Vines.*

	Water.	Ash.	Nitrogen.	Phosphoric Acid.	Potash.	Lime.	Magnesia.
Berries, Massachusetts,[1]	89.40	0.195	0.07	0.025	0.08	0.03	–
Berries, New Jersey,[2]	–	0.175	0.05	0.020	0.07	0.01	0.009
Vines, Massachusetts,[1]	13.07	2.450	0.77	0.270	0.33	0.40	0.250
Vines, New Jersey,[2]	–	2.070	0.64	0.180	0.24	0.49	0.190
Vines, New Jersey,[2]	–	2.100	0.65	0.310	0.40	0.50	0.190

A crop of 100 barrels of cranberries per acre, weighing 10,000 pounds, will contain only 7 pounds of nitrogen, 3 pounds of phosphoric acid and 8 pounds of potash. One ton of dried vines would contain 15 pounds of nitrogen, 6.2 pounds of phosphoric acid and 8 pounds of potash. These figures show clearly that the cranberry crop will never exhaust the potential fertility of the bog; but it is equally plain that it has become accustomed to a scanty nourishment, and they do not answer the question, "Shall fertilizers be used?"

There are on record only three series of fertilizer tests on the cranberry crop. They are somewhat empirical and throw little light on the problem.

An experiment in New Jersey was reported in 1895.[3] A complete fertilizer gave the best results, with the next best from the nitrogen with phosphorus and nitrogen with potash. This was indicative of the actual need of nitrogen; but the soil was described as a black sand somewhat too dry for a good bog.

In Wisconsin Whitson began a series of fertilizer tests in 1904,[4] the last detailed report of which was published in 1907.[5]

[1] Mass. State Exp. Sta. Rept., 1889, p. 274; 1893, pp. 330, 370.
[2] N. J. Agr. Exp. Sta. Rept., 1898, pp. 122, 123.
[3] Ann. Rept., N. J. Agr. Exp. Sta., 1895, p. 110.
[4] Whitson, A. R., Ann. Rept., Wis. Agr. Exp. Sta., 1905, pp. 291 and 292.
[5] Ann. Rept., Wis. Agr. Exp. Sta., 1907, p. 305.

The largest increase in fruit was from the use of sodium nitrate with acid phosphate, and the next best yield was from the nitrate with potash salts, while nitrate of soda alone was more effective than either of the other substances used singly. The actual character of the soil to which the fertilizers were applied is not stated, but from the general description of the bog it is inferred that the soil was a deep peat with the usual surface layer of sand.

In Massachusetts Brooks began a fertilizer test in 1906.[1] Three years later he reported [2] that nitrate of soda greatly promoted the growth of vines, and seemed to be favorable to fruitfulness, but when used in excess of 100 pounds per acre the growth of vines was liable to be too luxuriant. High-grade sulfate of potash was decidedly favorable, and the maximum yield was obtained from a heavy dressing of this salt supplemented by a moderate application of nitrate of soda and acid phosphate. The soil of the Massachusetts bog was not a deep peat, but a sand colored with peat as shown by a chemical analysis which revealed less than 2 per cent. of organic matter. In this instance there is evidence of a low potential fertility, which does not help clear up the problem of the use of fertilizers on a true peat soil.

When peat soils have been well drained and planted to common farm crops like corn, they have not been found to require nitrogen, but have been noticeably improved by the addition of potash salts and phosphates.[3] The conditions required by corn and staple farm crops differ, however, very much from those required by the cranberry. In the former conditions drainage is maintained continuously as a rule, while in the latter case the soil is saturated and even flooded through nearly three-fourths of the year. In the former case nitrification is favored, but in the latter case it is hindered, which may account for the agreement of all three fertilizer tests in showing an increase of fruit upon applications of nitrate of soda.

A consideration of the methods followed by cranberry growers in regulating the water supply of their bogs is helpful in connec-

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[1] Brooks, Wm. P., Ann. Rept., Mass. Agr. Exp. Sta., 1908, p. 17.

[2] Ann. Rept., Mass. Agr. Exp. Sta., 1910, p. 32.

[3] Hopkins, C. G., Soil Fertility, Ginn & Co., 1910, pp. 471–472; Whitson, A. R., Ann. Rept., Wis. Agr. Exp. Sta., 1905.

tion with a study of the natural fertility of the soil. Where conditions permit the bog is completely overflowed from some time in November until May, sometimes until the latter part of this month. During this period the changes within the soil must be limited to solution of matter in the water and putrefactive decomposition in the vegetable matter. Both will be at the lowest point because of the winter temperature. In the spring, when the sluices are opened, there is a rapid run-off from the surface followed finally by seepage into the ditches. The water table falls in the soil to a point a little higher than the level maintained in the drains. It is only above this water table that the activities of useful bacteria can occur, and while it is not definitely known how deep the cranberry roots penetrate, it is probable that they do not extend below the permanent water table. Through a large part of the growing season the water is maintained in the ditches at a level 12 to 15 inches below the surface of the soil. This permits oxidation changes and free root development in a soil depth of not more than 1 foot.

Moist sand is a well known medium for ærobic bacterial action, and the same is true of peat when it contains the optimum amount of water. Sewage filters are constructed of both types of soils, while several proposed processes for production of nitrates are based on the rapid nitrification known to take place in peat under favorable conditions.

During the summer season there must be a movement of water upward from the level of the water table into the surface peat and sand. This upward current is produced mainly by the transpiration of water from the plants, as they cover the surface so completely that actual evaporation must be small. But this makes little difference since it has been shown that transpiration follows the same laws as evaporation from a free surface.[1] Botanists have also observed that bog plants, for some reason, take on the character of desert plants and resist transpiration. The peat which is continually saturated or submerged must be constantly yielding soluble material to the enveloping water, and the solution must be nearly saturated. This soluble matter is poisonous to plants of many families, but

[1] Montgomery, Proc. Am. Soc. Agronomy, 1911, pp. 261, 283.

its influence on cranberry vines is not known. In the aerated surface soil, however, it will be transformed into the beneficial highly oxidized compounds, as nitrates and sulfates.

The present use of water on cranberry bogs is empirical, but a consideration of the conditions under which soil changes occur leads me to believe that water should be withdrawn from the surface at the earliest possible moment in the spring consistent with safety from frost, and held at the lowest possible level at which the vines can secure sufficient moisture for free growth during dry and hot weather. By this arrangement the period of active soil change, and the volume of soil in which it can take place, will be at a maximum, with a consequent increase in the amount of available nutrients for the plants. Flooding the bogs followed by the spring draining undoubtedly causes some loss of soluble fertility, and, on account of the close approach to saturation of the soil during the summer, heavy rains will also result in loss through seepage into the ditches.

This experiment station has begun an investigation of the problem of cranberry-bog fertility, and Director Brooks has devised a series of 30 miniature bogs described by him in a recent article.[1] Each bog is constructed in a 24-inch tile, 48 inches deep, and connected with it is a 6-inch tile that corresponds to the ditch on a large bog, by which the bog can be drained or irrigated. Analyses of the drainage water during the past two summers throw some light on the development of soluble material in the peat and its transformation into active nutrients for the vines. The first analyses were made on samples collected July 14, 1910. Other samples were analyzed at intervals until October 19. During most of this period frequent additions of water were required by the bog because the rainfall was abnormally small. All the water was applied to the surface of the bogs in order to promote diffusion into the small drainage cylinders.

There was much variation in the composition and also in the color of the different samples, which continued until the collection of September 12. There was, however, a steady progress toward uniformity. A few days previous to September 12, viz., on the 8th, there was an exceptionally heavy rainfall which

[1] Brooks, Wm. P., Proc. Soc. Promotion Agr. Sci., 1911, pp. 23-28.

flooded the bogs, covering the surface with an inch of water. The percolation which followed forced the bog water into the drainage cylinders. The water from nearly every bog on September 12 was a dark coffee color, whereas before this date there had been a wide range of tints from dark coffee to light amber. The total solids, and particularly the volatile solids, had now reached a maximum in all but two or three samples, and the amounts were of the same order of magnitude. When sampled for the last time in 1910, on October 19, there was another noticeable change in the water. Nearly all the samples were now a greenish black in color, and opaque and inky in appearance. They also were filtered with difficulty. All the samples collected during the season had been filtered through dry paper filters to remove suspended matter and sand. The water ran rapidly through the paper and in the earlier collections left little or no stain behind. As the colors deepened the later collections stained the filters more and more. The last series deposited a colloidal film on the paper which hindered the passage of the water through the pores and caused the filtration to occupy several hours, in some cases nearly twenty-four hours, while the filtered water had lost its inky appearance and was as a rule a light coffee color. This behavior, together with the appearance of a maximum point in the total solids and volatile solids, points conclusively to a saturated solution with respect to the organic constituents of the peat.

TABLE II. — *Inorganic Solids in Bog Waters, 1910.*

[Parts in 100,000.]

Bog Number.	July 14.	July 27.	August 22.	September 12.	October 19.
1,	11.8	34.8	53.0	62.4	59.6
2,	19.8	56.2	67.6	58.6	64.0
3,	31.4	49.8	76.6	64.6	63.8
4,	83.2	60.4	62.0	64.6	50.0
5,	73.6	69.4	70.0	53.8	59.6
6,	11.0	23.6	40.2	54.6	62.8
15,	11.2	–	52.0	73.4	68.0
16,	11.4	–	39.0	63.0	78.8
17,	54.6	49.4	51.4	63.0	–
18,	50.8	53.8	56.8	49.8	–
22,	63.4	56.2	58.6	49.0	–
25,	23.8	41.0	55.0	52.0	53.0

TABLE III. — *Organic Solids in Bog Waters, 1910.*

[Parts in 100,000.]

Bog Number.	July 14.	July 27.	August 22.	September 12.	October 19.
1,	5.8	12.8	18.6	94.0	73.6
2,	8.2	25.8	37.6	107.4	80.2
3,	10.4	16.4	28.0	112.6	94.0
4,	25.0	66.2	78.0	106.6	67.2
5,	44.8	62.6	70.4	131.2	101.2
6,	5.8	11.8	20.4	114.8	96.0
15,	3.2	–	22.0	102.8	101.2
16,	4.6	–	15.4	65.8	64.4
17,	54.4	89.2	101.6	93.8	–
18,	70.6	108.2	113.2	92.0	–
22,	48.6	60.2	118.0	96.6	–
25,	–	21.6	32.0	93.2	88.8

The inorganic solids were more or less influenced by the cement used in the construction of the cylinders.

The samples of 1911 are best considered in two groups, one of which represents the bog water in the spring, while the other shows its composition at the end of the summer. The first group consisted of two series of samples which were taken from 10 of the bogs on the 10th and 12th of May, before the flood water was drained off. The samples therefore represented the results of six months of solution, diffusion and precipitation on the organic and inorganic matter in the bogs. One set of samples was filtered through dry paper filters before they were analyzed, while the other set was allowed to stand over night to settle, and then used without filtering. The samples were inky in appearance when taken and changed but little on standing. Filtration required from twenty-four to forty-eight hours and a change of filter papers, because their surfaces were soon covered with a dark slime which rendered them nearly impervious. The filtered water was much lighter in color than the original sample. The material removed by the filters was largely organic in its nature, since the organic solids in the filtered water were lower proportionally than the inorganic

solids when compared with the corresponding figures for the unfiltered water.

TABLE IV. — *Average Composition of Bog Waters, May 10–12, 1911.*

	Organic Solids.	Inorganic Solids.
Unfiltered,	63.0	48.0
Filtered,	38.8	34.0

The behavior of the samples in filtering, their opaque appearance before it, and the lower solids compared with the results of the previous season, point toward a saturation of the water in the bogs by the soluble material in the soil.

On June 2 chemical fertilizers were added to 22 of the 30 bogs, and the bogs were renumbered in pairs; 1A, 1B to 15A, 15B, and each cylinder of a pair was a duplicate of the other.

TABLE V. — *Scheme for Fertilizers on Bogs, 1911.*

BOG NUMBER.	Nitrate Soda (Grams).	Acid Phosphate (Grams).	Sulfate Potash (Grams).	Calcium Hydrate (Grams).
1A, 1B,	3.25	–	–	–
2A, 2B,	–	13	–	–
3A, 3B,	–	–	6.5	–
4A, 4B,	3.25	13	–	–
5A, 5B,	3.25	–	6.5	–
6A, 6B,	–	–	–	–
7A, 7B,	–	13	6.5	–
8A, 8B,	3.25	13	6.5	–
9A, 9B,	6.50	13	6.5	–
10A, 10B,	–	–	–	–
11A, 11B,	–	–	–	–
12A, 12B,	3.25	26	6.5	–
13A, 13B,	3.25	13	13.0	–
14A, 14B,	–	–	–	–
15A, 15B,	3.25	13	6.5	65

NOTE. — Area of bogs, 1/14,000 of an acre.

After the fertilizers were added all irrigation of the bogs was executed by adding water to the drainage cylinders instead

of to the surface of the bogs. The rainfall was scanty during the summer, and frequent additions of water were necessary to maintain the water level within 14 to 16 inches of the surface. Beginning in the latter part of August, and continuing throughout September and October, frequent rains, some very heavy, caused copious percolation and resulted in considerable overflow from the drainage cylinders. Numerous samples were collected during this period and form the second group already mentioned. About two-thirds of these samples were analyzed after subsidence of sediment without filtration, and one-third were filtered through porcelain filter tubes under a pressure of 40 to 45 pounds per square inch. The character and appearance of the samples were like those of the May group. They were inky in color until filtered, and were then transparent and of varying shades of coffee color. The amount of solids was remarkably uniform and a little higher in the unfiltered water than was found in May, but much lower than the figures obtained the previous year. It is pretty conclusive that the peat had now become a stable bog soil, and the bog water had reached a stage of equilibrium with its soil environment.

TABLE VI. — *Organic Solids in Bog Waters, Unfiltered, 1911.*

[Parts in 100,000.]

Bog Number.	September 5.	September 11.	September 20.	October 3.	October 25.
1,	75.2	-	-	-	-
2,	84.6	-	-	-	-
3,	-	-	71.6	-	-
4,	-	-	87.2	89.2	-
5,	78.0	-	74.2	82.4	-
6,	-	-	-	-	86.4
7,	-	-	64.2	71.4	-
8,	80.0	79.0	-	79.0	86.4
9,	-	69.4	74.2	65.4	82.0
10,	-	-	-	64.6	89.1
11,	-	69.8	60.8	-	-
12,	82.8	-	-	64.8	88.6
13,	-	-	-	82.0	92.4
14,	63.4	79.2	75.8	77.0	92.0
15,	94.2	-	85.2	92.8	97.6

TABLE VII. — *Inorganic Solids in Bog Waters, Unfiltered, 1911.*

[Parts in 100,000.]

Bog Number.	September 5.	September 11.	September 20.	October 3.	October 25.
1,	50.4	-	-	-	-
2,	71.6	-	-	-	-
3,	-	-	68.8	-	-
4,	-	-	63.6	56.2	-
5,	61.4	-	63.8	51.6	-
6,	-	-	-	-	48.8
7,	-	-	58.6	48.6	-
8,	54.6	52.6	-	47.0	51 0
9,	-	50.6	47.8	41.0	49.4
10,	-	-	-	58.0	55.6
11,	-	63.8	56.9	-	-
12,	66.4	-	-	45.8	50.8
13,	-	-	-	43.0	51.0
14,	70.6	58.4	63.4	53.0	50.0
15,	68.6	-	66.2	54.4	65.2

TABLE VIII. — *Organic and Inorganic Solids in Bog Waters, Filtered, 1911.*

[Parts in 100,000.]

Bog Number.	Organic.			Inorganic.		
	August 24.	September 11.	October 25.	August 24.	September 11.	October 25.
1,	-	35.8	-	-	41.4	-
5,	29.8	-	-	36.6	-	-
6,	-	-	27.4	-	-	33.8
7,	20.0	-	-	21.4	-	-
8,	-	32.4	30.8	-	39.2	38.0
9,	14.4	28.0	35.0	20.4	34.2	44.8
10,	21.6	-	32.2	19.8	-	37.6
12,	-	-	47.2	-	-	43.6
13,	-	-	38.2	-	-	35.6
14,	-	37.4	33.6	-	47.1	32.2
15,	-	-	46.0	-	-	40.0

Since the primary object of the cranberry experiment is to ascertain the needs of the crop for fertilizers and the fate of

the fertilizing materials added to the soil, numerous determinations of the total nitrogen, free ammonia and nitrates were made on samples of water from the drainage cylinders between July 14 and Oct. 25, 1911. Nitrates were invariably found, but in insignificant amounts, and there was no practical difference between the water from bogs treated with nitrates and from those without them. Twenty-nine samples from bogs with nitrates contained 0.0299 part of nitric nitrogen in 100,000 parts of water, while 23 samples from bogs without nitrates contained 0.0298 part in 100,000. Free ammonia was much more prominent than nitrates and formed about one-third of the total nitrogen. There was a slight difference in favor of the fertilized bogs, since 34 samples from bogs fertilized with nitrate of soda contained 1.358 parts of ammonia in 100,000 parts of water, while 21 samples from bogs receiving no nitrates contained 1.227 parts of ammonia in 100,000. This slight difference indicates a possible denitrification and loss of nitrates in the form of ammonia. In determining total nitrogen about one-third of the samples were filtered through porcelain tubes before making the analysis. The slimy precipitate thus removed contained nearly two-fifths of the nitrogen present in the unfiltered waters. Forty-eight samples of unfiltered water contained 3.296 parts of nitrogen in 100,000 parts of water, while 27 samples of filtered water contained 2.058 parts of nitrogen in 100,000 parts of water.

TABLE IX. — *Total Nitrogen in Bog Waters, Unfiltered, 1911.*

[Parts in 100,000.]

Bog No.	Fertilizer.	September 5.	September 11.	September 21.	October 3.	October 9.	October 25.
1	Nitrate,	2.993	–	–	–	–	–
2	No nitrate,	3.977	–	–	–	–	–
3	No nitrate,	–	–	3.485	–	–	–
4	Nitrate,	–	–	4.100	3.767	–	–
5	Nitrate,	3.485	–	3.362	3.362	3.726	–
6	Nothing,	–	–	–	–	–	3.198
7	No nitrate,	2.911	–	2.993	2.788	3.280	–
8	Nitrate,	–	3.034	3.157	2.952	3.485	3.378
9	Double nitrate,	–	3.034	3.034	2.911	3.378	3.075
10	Nothing,	–	–	–	3.280	3.526	3.075
11	Nothing,	–	3.017	2.788	–	–	–
12	Nitrate,	3.485	–	–	3.280	3.526	–
13	Nitrate,	–	–	–	3.198	3.485	3.321
14	Nothing,	3.280	3.157	3.362	3.485	3.567	3.034
15	Nitrate,	3.977	–	3.936	3.854	–	3.485

Average nitrogen in 27 samples from nitrate bogs, 3.399 parts.

Average nitrogen in 18 samples from no nitrate bogs, 3.233 parts.

TABLE X. — *Total Nitrogen in Bog Waters, Filtered, 1911.*

[Parts in 100,000.]

BOG NUMBER.	August 9.	August 14.	August 24.	September 11.	October 25.
1,	-	-	-	2.583	-
4,	-	1.312	-	-	-
5,	-	1.476	1.722	-	-
6,	-	-	-	-	2.173
7,	-	0.820	1.107	-	-
8,	-	-	2.419	2.419	2.337
9,	-	-	-	2.337	2.419
10,	-	-	1.148	-	2.173
11,	-	0.984	-	-	-
12,	2.337	-	2.720	-	-
13,	2.173	-	-	-	2.337
14,	2.378	-	2.214	2.706	2.173
15,	2.665	-	2.829	-	2.747

In 1910 total nitrogen was determined in the waters from all the bogs on September 12, at the time of maximum total solids. The 29 samples of that date averaged 3.260 parts nitrogen in 100,000 parts of water, or practically like the average for 1911 in the unfiltered water.

A few determinations of phosphoric acid and potash were made in 1911 in the unfiltered waters. Samples were taken from bogs receiving fertilizers and from those without. The results were too nearly alike to justify any statements about the two groups, and only averages will be used to show the composition of the bog water. Eighteen samples representing 7 pairs of bogs contained an average of 1.772 parts of phosphoric acid in 100,000 parts of water. Sixteen samples representing 6 pairs of bogs contained an average of 5.15 parts of potash in 100,000 parts of water. A few analyses of filtered samples showed that the potassium compounds in the water were completely soluble and passed through the filters with the water; but practically all the phosphoric acid in the unfiltered water was removed by the filter with the slime. Since the slime when burned showed marked evidence of iron in the residue, it is probable that any phosphoric acid which dissolves in the bog

water soon becomes iron phosphate, which is well known as a highly gelatinous precipitate when formed in dilute solutions.

Summarizing the composition of the bog water from the analyses of September and October, 1911, we have the following figures as the average composition of the water standing in contact with the peat in a saturated condition.

TABLE XI. — *Average Composition of Bog Water.*

[Parts in 100,000.]

	Unfiltered.	Filtered.
Organic matter,	79.2400	31.8600
Inorganic matter,	55.6500	35.3600
Total nitrogen,	3.2960	2.0580
Free ammonia,	1.4500[1]	1.4500
Nitrogen in nitrates,	0.0417[1]	0.0417
Phosphoric acid,	1.7720	Traces.
Potash,	5.1500	5.1500

This preliminary study does not throw much light on the problem of fertilizing cranberry bogs. It points, however, to certain conditions worthy of consideration in the use of fertilizers. The cranberry crop does not draw heavily on the soil. Its period of growth is, however, comparatively short, especially if the flood water is retained late, and its soil volume is relatively small when the water level is maintained near the surface. Bog conditions do not favor nitrification and oxidation on account of the saturated soil and low temperature, hence the bog water is low in active fertilizing constituents, especially in nitrates. Therefore it is probable that small amounts of soluble chemicals applied in the late spring would be effective in stimulating growth.

[1] Ammonia and nitrates averaged somewhat higher during this period than for the season as a whole.

TYPES OF CORN SUITED TO MASSACHUSETTS CONDITIONS.

BY P. H. SMITH AND J. B. LINDSEY.

Introduction.

Since 1903 experiments have been in progress with corn to determine, if possible, those varieties, or rather types, best suited to Massachusetts conditions. With this end in view the total yield of dry matter per acre, the digestibility, the relative proportions, and in some cases the composition, of the various parts of the plant (stalk, leaf, ear and husk), and the relation of the stage of development to the relative proportion of different parts as affecting the food value have been carefully studied.

Soil, Cultivation, Size of Plots, Fertilizers used.

With the exception of the Eureka and Pride of the North, varieties tested in 1904, the corn was grown upon one-twentieth acre plots (30 by 73 feet), rows running east and west. The soil consisted of a light sandy loam such as might be considered satisfactory corn land. Each plot was liberally and uniformly fertilized.

1906. — Varieties: Leaming and Pride of the North.

Fertilizers used per acre: —

200 pounds high-grade sulfate of potash, equivalent to about 100 pounds potash.
300 pounds acid phosphate, equivalent to about 45 pounds available phosphoric acid.
200 pounds nitrate of soda, equivalent to about 30 pounds nitrogen.
200 pounds dry ground fish, equivalent to about 16 pounds organic nitrogen.

The corn planted in 1906 produced an exceptionally fine crop. This was evidently due to very favorable weather con-

ditions. The yield may also have been favored to some extent by the growth of medium green soy beans on the same plots the preceding year.

1907. — Varieties: Leaming and Pride of the North.

Fertilizers used per acre: —

200 pounds high-grade sulfate of potash, equivalent to about 100 pounds potash.
500 pounds phosphatic slag, equivalent to about 75 pounds available phosphoric acid.
200 pounds nitrate of soda, equivalent to about 30 pounds nitrogen.
300 pounds dry ground fish, equivalent to 24 pounds organic nitrogen.

1908. — Varieties: Sanford, Longfellow, Rustler, Early Mastodon, Klondike, Red Cob Silage and White Cap Yellow.

Fertilizers used per acre: —

300 pounds high-grade sulfate of potash, equivalent to about 150 pounds potash.
500 pounds acid phosphate, equivalent to about 75 pounds available phosphoric acid.
200 pounds nitrate of soda, equivalent to about 30 pounds nitrogen.
500 pounds dry ground fish, equivalent to about 40 pounds organic nitrogen.

1909. — Varieties: Twitchell's, Rustler, Brewer's, Early Mastodon, White Cap Yellow, Wing's Improved White Cap.

Fertilizers used per acre: —

300 pounds high-grade sulfate of potash, equivalent to about 150 pounds potash.
700 pounds acid phosphate, equivalent to about 105 pounds available phosphoric acid.
200 pounds nitrate of soda, equivalent to about 30 pounds nitrogen.
500 pounds dry ground fish, equivalent to about 40 pounds organic nitrogen.

1910. — Varieties: Rustler, Brewer's, Longfellow, Eureka.

Fertilizers used per acre: —

300 pounds high-grade sulfate of potash, equivalent to about 150 pounds potash.
700 pounds acid phosphate, equivalent to about 105 pounds available phosphoric acid.
200 pounds nitrate of soda, equivalent to about 30 pounds nitrogen.
500 pounds dry ground fish, equivalent to about 40 pounds organic nitrogen.

A larger amount of fertilizer was added during the last few years of the experiment in order to insure the maximum development of the crop. The yield of corn when planted on the same land for several successive years is likely to decrease, and it was thought that the additional amount of plant food applied would in a measure check this probable shrinkage.

The chemicals were mixed, sown broadcast and harrowed in just before the corn was planted. While the application of commercial fertilizer was liberal, it is believed that larger yields might have been secured, in some cases at least, if more organic matter had been added to the soil either through the medium of barnyard manure or as a cover crop to be ploughed under in the spring.

The Pride of the North and Eureka corn grown in 1904 were not planted on the twentieth-acre plots, but were grown on one-half acre plots in an adjoining field. It was fertilized with cow manure at the rate of six cords to the acre and the land well fitted. In this case the rows ran north and south and the corn was sown in drills and thinned to one plant to the foot at the time of hoeing.

The corn grown on one-twentieth acre plots was planted in hills 3½ by 3½ feet, and thinned to four plants at the time of hoeing. It was seeded May 20–25 and harvested September 15, which is about as late as it is advisable to allow corn to stand and be safe from frosts.

Description of Varieties.

Twitchell's. — A small growing yellow flint bred in Maine. On account of its early maturing qualities (with us in the vicinity of August 20) it may be grown as far north as corn culture can be considered profitable. It has a short stalk of small diameter and a good-sized ear, in some cases two ears being noted on each stalk. It cannot be considered well suited for forage or silage where larger varieties will mature.

Sanford White. — A white flint corn, quite like Longfellow in general appearance, size of plant and time of ripening.

Longfellow. — An old established yellow flint variety extensively grown in Massachusetts. It is one of the best of the yellow flint varieties.

Pride of the North. — One of the earliest and apparently most satisfactory yellow dent varieties for Massachusetts. It does not usually make as large a growth as the Leaming, but in an average season will reach maturity.

Rustler Minnesota Dent. — A white dent corn believed to have been first raised in Massachusetts, on the Agricultural College farm, from seed procured in Minnesota. It has given uniformly good results and can be considered a satisfactory dent variety in spite of the fact that the ears do not usually develop well at the tip. It is believed that this corn can be greatly improved by careful breeding.

Leaming. — Yellow dent. Somewhat like the Pride of the North, but makes a larger growth and matures a little later. It is extensively grown for silage in Massachusetts, and, unless the season is unusually backward, will mature sufficiently for this purpose.

Brewer's. — Yellow dent. This is believed to be a western dent variety improved by N. H. Brewer of Hockanum, Conn. Mr. Brewer has raised enormous crops by following an intensive system of fertilization and cultivation. We have not been successful in ripening it on the station farm. At the time of cutting (September 15) the ears were hardly in milk, and consequently not suitable to harvest for grain. It evidently needs a somewhat longer growing season than is usually experienced in the vicinity of Amherst.

Early Mastodon. — Yellow dent. Bred by C. S. Clark of Ohio. A large growing variety evidently rather too late for grain in Massachusetts.

Klondike. — Yellow dent. Quite like the Early Mastodon in appearance, but noticeably later and unsuited to New England conditions.

Red Cob Silage. — White dent. Medium late.

White Cap Yellow Dent. — Resembles Leaming in size, but matures rather later. Fairly satisfactory for silage.

Wing's Improved White Cap. — Originated by J. E. Wing of Ohio. Some of the stalks bore two ears. It would probably form a very satisfactory variety in the middle western States, but the season is not sufficiently long to enable it to reach maturity in New England.

Eureka White Dent. — A large growing southern variety. It reaches a height of some 13 or more feet and has very coarse stalks. It has never matured in Amherst. The ears set very high on the stalk and the kernels are forming by September 15.

Yield Per Acre of Entire Corn Plant (Pounds).

Year.	Variety.	Condition.	Total Yield.	Dry Matter.
1909	Twitchell's,	Mature,	13,800	4,236
1908	Sanford White,	Mature,	28,400	8,148
1908	Longfellow,	Mature,	34,960	8,981
1910	Longfellow,	Mature,	25,400	6,480
1904	Pride of the North,	Fairly ripe, kernels glazing,	27,800	6,253
1906	Pride of the North,	Mature,	42,600	11,664
1907	Pride of the North,	In milk, not quite ripe,	28,500	5,141
1908	Rustler,	Mature,	23,067	7,843
1909	Rustler,	Mature,	27,100	5,328
1910	Rustler,	Mature,	22,400	6,772
1906	Leaming,	Mature,	51,560	12,307
1907	Leaming,	In milk, not quite ripe,	28,200	5,144
1909	Brewer's,	In milk, green,	35,100	6,286
1910	Brewer's,	In milk, green,	28,100	7,226
1908	Early Mastodon,	In milk to dent stage, green,	39,320	9,488
1909	Early Mastodon,	In milk to dent stage, green,	36,220	6,436
1908	Klondike,	Green and poorly eared,	37,340	9,069
1908	Red Cob Silage,	In milk to dent stage, green,	43,500	11,210
1908	White Cap Yellow,	In milk to dent stage, green,	35,300	11,038
1909	White Cap Yellow,	In milk to dent stage, green,	24,900	5,784
1909	Wing's Improved White Cap,	In milk, green,	28,300	5,671
1904	Eureka,	Immature, kernels scarcely formed,	40,800	6,671
1910	Eureka,	Immature, ears just forming,	43,800	9,044

The preceding table shows the total yield per acre as cut and also the total yield of dry matter. The entire crop for each one-twentieth acre plot was cut and immediately hauled to the barn and weighed. The dry matter was determined by taking a representative sample at the time of harvesting, running it through a cutter, subsampling, placing the subsample in a glass-stoppered jar and drying at 100° C.

Twitchell's corn was well matured in spite of the unfavorable season, and although the 4,236 pounds of dry matter

were much less than for any of the other varieties, it probably represented a fair average yield of its kind.

The yields of Longfellow and Sanford, both grown in favorable seasons, may be considered normal in amount. The season of 1908 was rather better than 1910, which would probably account for the larger yield of Longfellow corn in the former year.

Pride of the North was grown during three seasons. The seasons of 1904 and 1907 were both unfavorable, while 1906 was especially satisfactory, and in this year it yielded approximately twice as much dry matter as was secured in the average crop of the other two seasons.

Rustler, also grown for three seasons, showed a reasonably uniform dry matter content with the highest yield in the more favorable season (1908).

Leaming, grown in a favorable and unfavorable season, yielded over twice as much dry matter in the favorable year.

Brewer's dent, which evidently needs a longer growing season for its maturity than the average in Massachusetts, did not show a very decided variation between the two years.

Early Mastodon and White Cap Yellow, both grown in 1908 and 1909, showed the larger yields in 1908, the more favorable year.

Klondike and Red Cob Silage were both grown in 1908, a favorable year. Neither ripened satisfactorily, but showed good yields of dry matter. The former was noticeably immature when harvested.

Wing's Improved White Cap — grown in 1909, a poor corn year — did not yield well, and evidently needs a longer growing season.

Eureka, grown in 1909 and 1910, showed the better yield in 1910. In neither case was the corn well matured, nor did it show a larger yield of dry matter than some of the smaller varieties that showed a very much larger percentage of mature ears.

The total yield of dry matter, rather than the green material, gives a much better indication of the value of the crop for feeding purposes. A green, immature crop will often furnish a large apparent yield, but it contains an excessive amount of

water. This fact is especially evidenced by the Eureka and Klondike which, while they gave high yields of green material, did not show the highest production of dry matter.

Morrow,[1] as a result of four years' observations, states that in no year was there more than half the total amount of dry matter when the plant had reached its full height, and not more than 75 per cent. of the maximum when the ears were in dough stage. Ladd,[2] as a result of a two years' experiment, found the greatest weight of green fodder to be between the period of full silking and milky stage of kernel, and that while the total weight diminished after this date the total dry matter increased. Our own results, corroborated by those of other investigators, indicate that such varieties as the Twitchell, Sanford, Longfellow, Pride of the North (in one case) and Rustler can be considered as having reached a maximum weight in dry matter under the conditions in which they were grown. The remaining varieties, with the exception of the Eureka, would surely have increased in dry matter and decreased in total weight had their growing season been longer, while the Eureka would probably have increased in both total weight and dry matter. On account of their high water content and less mature condition the last 8 varieties in the preceding table cannot be considered as valuable pound for pound as the more mature types.

Effect of Season on Yield.

The following data, taken from the Massachusetts Crop Report, will show the weather conditions for the years during which the corn was grown: —

1904. Season, as a whole, cool and dry which made corn unusually late and poorly ripened.

1906. Season, as a whole, warm, especially in July and August. Good rainfall in June and July, hot and humid weather in August, with warm, dry weather the first part of September. The weather conditions were very favorable for corn and the crop ripened exceedingly well.

1907. Season, as a whole, hot and dry. August being the hottest month for thirty-six years. A late spring, together with succeeding dry weather, hindered the development of the crop which was below normal.

[1] Bul. No. 25, Ill. Exp. Sta., p. 200.
[2] Eighth Ann. Rept., N. Y. Exp. Sta., p. 90.

1908. Season variable, with high temperature and rainfall at opportune times. July hot with little rain till the last part. August cool with plenty of rain. The early part of September dry and warm which hastened the development of the crop that was exceptionally good.

1909. Season, as a whole, dry and cool. The crop germinated well, but the growth was checked by drought and cool weather to such an extent that in many cases the ears did not ripen in spite of no killing frosts until late.

1910. Season, as a whole, hot and dry. Rain at such times as to greatly benefit crop, which was above normal and well matured.

The most striking feature brought out by the preceding table is the extreme variation in yield, not only between different varieties, but between the same varieties grown in different years. This point is well illustrated by Pride of the North, grown in 1904, 1906 and 1907, the yield being a third more for 1906, a very favorable corn year. Morrow[1] found this to be the case in experiments conducted in Illinois, and states that the rain and heat were more influential on the rate of growth than the difference in the variety of corn. It is believed that the total yield of dry matter can be affected by climatic conditions in two ways: a lack of rain at critical periods may cause the corn to ripen before it has obtained its maximum growth, while a cold, wet season will retard the growth of the crop so that it does not reach maturity in the growing season.

The data in the above table make especially clear that: —

1. The small varieties as represented by the Twitchell, because of the relatively low yield of total dry matter, are not economical for Massachusetts conditions.

2. The flint varieties, such as Longfellow and Sanford and the medium dents — Rustler and Pride of the North — are quite well suited for grain and also serve fairly well for silage.

3. The larger medium dents — including the Leaming, White Cap Yellow, Red Cob and Early Mastodon — give a very good yield of dry matter, and in average season bring their ears to the milk stage. All conditions considered, these varieties are rather preferable for silage purposes.

4. The coarse, late maturing varieties as represented by the

[1] Bul. No. 31, Ill. Exp. Sta., p. 363.

Klondike, Wing's Improved, Brewer's, and particularly the Eureka, while yielding a fair average amount of dry matter are not satisfactory because of their failure to mature; the resulting silage has been repeatedly shown by other observers as being watery, sour and of less nutritive value.

5. The season has a marked influence upon the yield of the corn crop, the same variety of corn under otherwise identical conditions yielding from 50 to 100 per cent. more in a year particularly favorable to its growth.

Composition of Different Varieties of Corn Fodder (Entire Plant) (Per Cent.).

[As harvested.]

Number of Analyses.	Variety.	Water.	Protein.	Fat.	Nitrogen-free Extract.	Fiber.	Ash.
1	Twitchell's,	69.11	3.03	.94	20.21	5.34	1.37
1	Sanford White,	71.31	1.97	.75	19.03	5.78	1.16
1	Longfellow,	74.31	2.30	.60	16.38	5.03	1.38
6	Pride of the North,	75.33	2.02	.60	15.74	5.18	1.13
3	Rustler,	71.62	2.17	.68	18.36	5.94	1.23
4	Leaming,	76.85	1.77	.47	14.21	5.60	1.10
2	Brewer's,	81.35	1.82	.27	10.90	4.72	.94
3	Early Mastodon,	77.77	1.86	.41	13.77	5.14	1.05
1	Klondike,	75.71	1.31	.42	14.09	6.98	1.49
1	Red Cob Silage,	74.23	1.58	.40	15.69	6.93	1.17
2	White Cap Yellow Dent,	72.75	2.17	.50	17.38	6.02	1.18
2	Wing's Improved White Cap,	80.39	1.72	.32	12.06	4.53	.98
1	Eureka,	82.58	1.63	.27	9.26	4.78	1.08

Composition of Different Varieties of Corn Fodder (Entire Plant) (Per Cent.).

[Dry Matter.]

Number of Analyses.	Variety.	Protein.	Fat.	Nitrogen-free Extract.	Fiber.	Ash.
1	Twitchell's,	9.82	3.05	65.43	17.28	4.42
1	Sanford White,	6.85	2.61	66.36	20.13	4.05
1	Longfellow,	8.96	2.34	63.77	19.56	5.37
6	Pride of the North,	8.18	2.43	63.08	21.01	4.58
3	Rustler,	7.66	2.39	64.68	20.94	4.33
4	Leaming,	7.63	2.01	61.40	24.19	4.77
2	Brewer's,	9.75	1.43	58.43	25.33	5.06
3	Early Mastodon,	8.37	1.85	61.97	23.10	4.71
1	Klondike,	5.43	1.72	57.99	28.74	6.14
1	Red Cob Silage,	6.12	1.57	60.87	26.90	4.54
2	White Cap Yellow Dent,	7.98	1.83	63.78	22.10	4.33
2	Wing's Improved White Cap,	8.75	1.65	61.48	23.10	5.02
1	Eureka,	9.34	1.54	55.52	27.41	6.19

The varieties of corn given in the preceding tabulation can be divided into four different groups according to their period of ripening.

1. Mature (dents and flints): Twitchell's, Sanford White, Longfellow, Pride of the North and Rustler.

2. Medium mature (coarse dents): Leaming, Early Mastodon, Red Cob Silage and White Cap Yellow Dent.

3. Immature (very coarse dent): Brewer's, Klondike and Wing's Improved White Cap.

4. Very immature (very coarse dent): Eureka.

The average water content of the four groups was as follows: —

	Per Cent.
Mature,	74.34
Medium mature,	75.40
Immature,	79.15
Very immature,	82.58

While there is a gradual diminution in the water content from the time that the ears are formed until maturity, as shown by this table, the total dry matter gradually increases to maturity.[1]

It is not believed that, owing to individual variations, conclusions can be readily drawn relative to the chemical composition of the different varieties. By averaging the four groups previously given the following results are obtained: —

Dry Matter (Per Cent.).

	Protein.	Fat.	Nitrogen-free Extract.	Fiber.	Ash.
Mature,	8.29	2.56	64.81	19.78	4.55
Medium mature,	7.52	1.82	62.00	24.07	4.59
Immature,	7.97	1.60	59.30	25.72	5.41
Very immature,	9.34	1.54	55.52	27.41	6.19

The very green, immature corn contains a larger relative percentage of protein, but more of it in the amido form.[2] The fat, and particularly the nitrogen-free extract matter, increase the more mature the variety. This is to be expected, for the corn is a carbohydrate plant, and stores up large amounts of starch in the latter stages of its growth. As the starch increases the percentage of fiber and ash relatively decrease. The ash is always at its highest point in the early stages of development.

[1] Ladd, N. Y. Exp. Sta., Rept., 1889.

[2] Eighth Ann. Rept. N. Y. Exp. Sta., p. 90.

The preceding facts are substantiated by the investigations of Schweitzer,[1] Jordan,[2] Ladd [3] and others.

The general conclusion can be drawn that the changes in chemical composition which the plant undergoes in its development are such that its maximum feeding value exists at its maturity.

Digestibility of the Plant.

The digestibility of 7 representative varieties of the entire plant was determined with sheep. The method followed in conducting such experiments is illustrated and described in detail elsewhere.[4] The entire data of the several experiments have been presented in previous reports; only the digestion coefficients, therefore, are given in this connection. As only four sheep were available, but two duplicate digestion trials could be completed in a single season. The method of procedure was as follows: each experiment was begun about September 5th, when the sheep received their first feeding. The corn was allowed to stand in the field, sufficient being cut for only two consecutive days. The entire digestion period lasted fourteen days, the first seven of which were preliminary. The corn was cut in 2-inch pieces before being fed. Two days' feeding were weighed out in advance, and samples taken for dry-matter determinations and for complete chemical analysis. The difference between the amount and chemical composition of the fodder fed and the amount and chemical composition of the feces excreted served as a basis for computing the amount digested and utilized by the animals.

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[1] Bul. No. 9, Mo. Exp. Sta.

[2] Ann. Rept. Me. Exp. Sta., 1893.

[3] Eighth Ann. Rept. N. Y. Exp. Sta., 1899.

[4] Eleventh Rept. of the Mass. State Agr. Exp. Sta., pp. 126–149; also 22d Rept. of the Mass. Agr. Exp. Sta., p. 84.

Digestion Coefficients.[1]
[Per Cent. Dry Matter digested.]

Variety Corn.	Condition of Crop at Time of Harvest.	Digestion Coefficients.					
		Dry Matter.	Protein.	Fat.	Nitrogen-free Extract.	Fiber.	Ash.
Pride of the North,	In dough to denting,	71	63	76	77	65	34
Pride of the North,	In dough to denting,	77	63	84	84	66	36
Rustler,	In dough to denting,	69	43	76	78	59	28
Leaming,	Corn in late milk,	70	60	76	77	61	36
Brewer's,	Corn in milk,	72	69	68	77	69	46
Early Mastodon,	Corn in milk,	72	57	81	79	60	36
Wing's Improved White Cap,	Corn in milk,	70	63	70	76	65	39
Eureka,	Kernels just forming,	67	67	66	72	60	42
Pride of the North stover,	– – –	54	45	64	54	60	31
Eureka stover,	– – –	54	48	67	53	59	45

A study of the above coefficients shows no wide variations in the relative digestibility of the several varieties. Naturally the larger the percentage of ear present the higher should be the digestibility of the entire plant, the grain having a much higher digestibility than the stalk. This in a general way is made clear by classifying the results according to the stage of growth. Corn that is immature and with ears partially formed may show nearly as high an absolute digestibility as a mature variety because of the soft, incompletely developed stalks. If it had been possible to determine the net available energy of each variety according to the method employed by Kellner,[2] those varieties having the mature ears would unquestionably have shown a much larger amount of energy than the less mature varieties.

Attention may also be called to the variation in the percentage of nitrogen-free extract of the several varieties. With one exception [3] the digestibility varies to a limited extent inversely

[1] For figures in detail see supplement.

[2] The Scientific Feeding of Animals, pp. 48-50.

[3] In case of Rustler Dent rather more was fed than the animals could well utilize, which explains the low coefficient for this variety.

with the percentage of nitrogen-free extract, or, otherwise explained, the larger the percentage of extract or starchy matter present, the higher the digestibility of the corn plant.

A division and tabulation of the results according to the stage of growth of the varieties gives us the following results:[1] —

Dry Matter.

	Average Yield per Acre.	Per Cent. digested.	Pounds per Acre digested.
Mature,	7,686	74	5,688
Medium mature,	8,344	71	5,924
Immature,	6,394	71	4,540
Very immature,	7,858	67	5,265

It would appear from the above that the larger growing varieties, such as Leaming, Red Cob, Early Mastodon and White Cap, will produce rather more dry and digestible matter than do the medium dent or flints as typified in the Longfellow or Rustler, and the former varieties, on the whole, are to be given the preference for silage purposes. It is questionable, however, if they furnish any more final nutritive effect (net available energy) than do the varieties that will thoroughly mature by the middle of September. The percentage of dry matter digested, on the other hand, is in favor of the mature varieties. The extremely late varieties, such as the Eureka and Klondike, are not at all suited to New England conditions.

Experiments were made with a sample of Pride of the North and a sample of Eureka corn stover during the year of 1904, the two lots proving to be equally digestible. The former variety of stover contained 18.13 per cent. of water when sampled (December 27), and the latter contained 59.92 per cent. (February 29). Both samples had been stored in the barn since late autumn. When drawn from the field the former contained 37.84 per cent. and the latter 68.92 per cent. of water. The Eureka stover, because of its coarse, immature condition, retained the moisture to a much greater extent than did the fully matured corn.

[1] Omitting coefficients for Rustler Dent from the mature varieties.

Proportions and Composition of Parts.

(*a*) *Proportions at Time of Cutting* (*100 Pounds*).

Year.	Variety.	Stalks.	Leaves.	Husks.	Ears.
1909	Twitchell's,	27	26	10	37
1908	Sanford White,	45	20	11	24
1908	Longfellow,	48	21	10	21
1910	Longfellow,	38	25	9	28
1901	Pride of the North,	47	20	11	22
1906	Pride of the North,	40	17	12	31
1907	Pride of the North,	52	16	14	18
1908	Rustler,	46	19	7	28
1909	Rustler,	41	14	15	30
1910	Rustler,	40	19	9	32
1906	Leaming,	48	19	11	22
1907	Leaming,	52	17	12	19
1909	Brewer's,	51	17	13	19
1910	Brewer's,	53	17	10	20
1908	Early Mastodon,	52	19	9	20
1909	Early Mastodon,	50	18	12	20
1908	Klondike,	62	19	9	10
1903	Red Cob Silage,	53	17	12	18
1908	White Cap Yellow,	46	19	11	24
1909	White Cap Yellow,	50	16	12	22
1909	Wing's Improved White Cap,	52	19	10	19
1901	Eureka,	64	22	7	7
1910	Eureka,	62	21	7	10

(*b*) *Proportions in Dry Matter* (*100 Pounds*).

Year.	Variety.	Stalks.	Leaves.	Husks.	Ears.
1909	Twitchell's,	15	21	9	55
1908	Sanford White,	35	20	10	35
1908	Longfellow,	34	18	9	39
1910	Longfellow,	23	21	7	49
1901	Pride of the North,	37	18	9	36
1906	Pride of the North,	28	14	9	49
1907	Pride of the North,	50	19	11	20
1908	Rustler,	33	19	7	41
1909	Rustler,	32	13	12	43
1910	Rustler,	30	17	8	45
1906	Leaming,	41	19	9	31

(*b*) *Proportions in Dry Matter (100 Pounds)* — Concluded.

Year.	Variety.	Stalks.	Leaves.	Husks.	Ears.
1907	Leaming,	48	20	10	22
1909	Brewer's,	51	20	12	17
1910	Brewer's,	47	20	10	23
1908	Early Mastodon,	44	19	9	28
1909	Early Mastodon,	47	21	11	21
1908	Klondike,	59	22	7	12
1908	Red Cob Silage,	50	19	11	20
1908	White Cap Yellow,	38	19	10	33
1909	White Cap Yellow,	47	19	11	23
1909	Wing's Improved White Cap,	52	23	9	16
1904	Eureka,	63	25	6	6
1910	Eureka,	59	28	6	6
	Average,	42	20	9	29

Condition of Crop when cut and Character of Season.

1904. *Poor Corn Year.* — Varieties grown: Pride of the North and Eureka. In spite of the unfavorable season, Pride of the North was fairly ripe when cut and contained a fair proportion of ear. The Eureka was quite immature, with ears just forming.

1906. *An Exceptionally Favorable Corn Year.* — Varieties grown: Pride of the North and Leaming. Both matured, gave a large total yield and showed a noticeably large proportion of ears.

1907. *Poor Corn Year.* — Varieties grown: Pride of the North and Leaming. Neither variety did as well as in 1906 and the proportion of ear was much less.

1908. *Satisfactory Corn Year.* — Varieties grown: Sanford White, Longfellow, Rustler, Early Mastodon, Klondike, Red Cob Silage and White Cap Yellow. Of these the first three were fully developed when cut, and showed a larger development of ear than did the last four, which were in the milk-to-denting stage. White Cap Yellow was the best developed of the last-named varieties, and showed a fair proportion of ear.

1909. *Poor Corn Year.* — Varieties grown: Twitchell's, Rustler, Brewer's, Early Mastodon, White Cap Yellow, Wing's Improved White Cap. The first two varieties matured. The Twitchell, a very small variety, has a short stalk with a long ear setting low on the stalk. It showed the largest proportion of ear of any variety raised. The last three varieties were in milk when cut.

1910. *Favorable Corn Year.* — Varieties: Longfellow, Rustler, Brewer's, Eureka. The first two varieties were mature when cut. Brewer's was in milk and the ears just forming on the Eureka.

It will be observed that in many cases the proportion of the several parts differ in the green stage and on the dry-matter basis. Thus Twitchell's shows 27 per cent. of stalk when cut and only 15 per cent. when all of the water is eliminated. Sanford White shows 24 per cent. of ears when cut and 35 per cent. in dry matter.

The remarks which follow refer to the proportions of the parts on the basis of dry material. In general it may be said that there is a wide difference between the proportion of stalks and ears; the difference between the leaves and husks is less marked.

A decided difference is noted between the *same variety* grown *in different* years. This variation is evidently due, to some extent, to the stage of maturity of the plant when cut and also to unfavorable conditions, which checked the development of the ear. *The stalks and ears form practically 70 per cent. of the dry matter of the plant. The leaves and husks 30 per cent.* From the data at hand the inference can be drawn that this is an inherent characteristic of the maize plant. While other investigators [1] have determined the relative proportions of the plant, it is believed that this fact has not before been noticed.

Those coarse varieties maturing late naturally have less ear and a correspondingly larger proportion of stalk. Note the mature varieties, including the Longfellow with an average of 28 per cent. of stalk and 44 per cent. of ears; the Pride of the North with an average of 38 per cent. of stalk and 35 per cent. of ears; the Rustler with 32 per cent. of stalk and 35 per cent. of ears, against the later maturing varieties, such as the Brewer's with 49 per cent. of stalk and 19 per cent. of ears; the Leaming with 44 per cent. of stalk and 26 per cent. of ears; and finally the Eureka with 61 per cent. of stalk and 6 per cent. of ears. On the whole, the proportion of leaves and husks does not vary widely in any of the varieties, averaging 20 per cent. for the leaves and 9 per cent. for the husks. The Eureka shows rather

[1] Schweitzer, Bul. No. 9, Mo. Exp. Sta., Caldwell, Bul. Nos. 7–11; Rept. of 1890, pp. 30–43, Pa. Exp. Sta.; Bul. No. 21, Iowa Exp. Sta.

more leaf and correspondingly less husk than the other varieties; in fact, this variety as cut was largely stalk and leaf.

The following general conclusions can be drawn: —

1. The stalks and ears form substantially 70 per cent. of the entire maize plant.

2. The small, early maturing varieties of which the Twitchell is a type show an exceptionally large proportion of ears.

3. The mature medium varieties average 33 per cent. of stalk and 37 per cent. of ears.

4. The coarser, less mature varieties show 45 per cent. of stalk and 26 per cent. of ears.

5. The very coarse, immature varieties (excepting Eureka) show 52 per cent. of stalks and 17 per cent. of ears.

6. Most of the varieties have in the vicinity of 20 per cent. of leaves and 10 per cent. of husks.

The above conclusions are for corn grown in Massachusetts and cut about September 15. These conclusions might not hold, especially for the larger immature varieties, had they been ripe at the time of cutting.

Average Composition of Parts (Per Cent.).

Number of Analyses.	Variety.	Water.	Dry Matter.				
			Protein.	Fat.	Nitrogen-free Extract.	Fiber.	Ash.
	Stalks.						
2	Pride of the North,	79.84	4.04	.89	56.52	32.91	5.64
2	Leaming,	80.97	3.91	.94	58.94	31.56	4.65
1	Eureka,	83.08	4.80	1.07	52.94	35.77	5.42
	Leaves.						
2	Pride of the North,	76.28	13.99	3.39	48.89	24.06	9.67
2	Leaming,	76.53	13.65	3.03	48.89	25.16	9.27
1	Eureka,	81.17	14.53	2.43	45.63	28.43	8.98
	Husks.						
2	Pride of the North,	77.49	5.14	1.36	62.23	27.98	3.29
2	Leaming,	81.87	6.77	1.50	61.69	26.74	3 30
1	Eureka,	85.35	8.66	1.46	62.22	24.64	3.02
	Ears.						
2	Pride of the North,	56.54	9.53	3.73	75.50	9.46	1.78
2	Leaming,	71.77	9.56	2.90	71.48	13.82	2.24
1	Eureka,	86.91	12.00	1.44	63.84	19.47	3.25

While the analyses are not sufficient in number to enable one to draw any positive conclusions, attention may be called to a few of the more striking facts.

Stalks. — A comparatively low percentage of both protein and fat is noted in the stalks of all the several kinds. The proportion of extract matter is lowest in the Eureka and the fiber percentage the highest.

Leaves. — The protein percentage is highest in the leaves. Naturally, the fiber percentage is less in the leaves than in the stalks, while the percentage of ash is noticeably high and quite constant for the three types. The leaves of the three varieties analyzed resemble each other quite closely in the proportion of all of the several groups of constituents.

Husks. — The one noticeable difference in the case of the husks of the several varieties consists in the low protein content in the Pride of the North and the high protein content of the Eureka. This is, of course, due to the fact that the ears of the latter were in the formative stage, while those of the former had matured and the protein had entered into the kernel. The fiber content of the Pride of the North was somewhat higher than that contained in the Eureka, which is explained on similar grounds.

Ears. — The composition of the ears of the three varieties indicate a very immature condition on the part of the Eureka, — high protein and fiber and low carbohydrates and fat, — and a reasonably mature condition of the ears yielded by the Pride of the North and Leaming.

Relative Proportions of Grain and Cob.

Ten representative ears of corn were selected at the time of husking from the crops of 1908 and 1909 and preserved for analysis. The corn and cob were weighed separately at the time of shelling, dry-matter determinations made, and percentage of cob and kernel determined.

Weights of Ten Average Ears with Proportion of Kernel and Cob in Dry Matter.

Variety.	Condition when cut.	Dry Matter (Pounds).			Dry Matter (Per Cent.).	
		10 Ears.	Kernel.	Cob.	Kernel.	Cob.
Twitchell's,	Mature.	3.37	2.93	.44	86.9	13.1
Sanford White,	Mature.	3.37	2.65	.72	78.6	21.4
Longfellow,	Mature.	3.53	2.95	.58	83.6	16.4
Rustler,	Mature.	4.71	4.08	.63	86.6	13.4
Rustler,	Mature.	4.87	4.23	.64	86.9	13.1
Average,	. .	3.97	3.37	.60	84.5	15.5
Brewer's,	In milk.	4.29	3.57	.72	83.2	16.8
Early Mastodon,	In milk.	4.05	3.37	.68	83.2	16.8
Early Mastodon,	In milk.	5.48	4.55	.93	83.0	17.0
Klondike,	In milk.	3.60	2.66	.94	73.9	26.1
Red Cob Silage,	In milk.	4.37	3.59	.78	82.2	17.8
White Cap Yellow,	In milk.	3.70	3.12	.58	84.3	15.7
White Cap Yellow,	In milk.	3.71	3.11	.60	83.8	16.2
Wing's Improved White Cap,	In milk.	4.14	3.39	.75	81.9	18.1
Average,	. .	4.17	3.42	.75	81.9	18.1

Wide variations were noted depending upon stage of ripeness. The Twitchell, a long eared and early maturing flint, showed the smallest percentage of cob (13.1), and the Klondike, a quite immature dent, the largest amount of cob (26.1). The average of the several mature types was 15.5 per cent. cob, and 84.5 per cent. kernel, while the average for the less mature varieties was 18.1 for cob and 81.9 for kernel. If the less mature varieties had been grown in a climate favorable to their complete maturity, it is probable that they would have shown equally as favorable a proportion of cob and kernel.

The weight of the Massachusetts legal bushel in case of shelled corn is 56 pounds, and for a bushel of ears 70 pounds. This allows 14 pounds, or 20 per cent., for the cob. With but two exceptions the samples tested contained less than 20 per cent. cob in dry matter. Assuming that the standard of 70 pounds per bushel for corn was based upon the average of a large number of trials, is it not possible that the corn crop has

been improved since the time that such a standard was adopted, and that corn is now being grown that contains relatively less cob and more kernel than formerly?

The results of these trials are substantiated by work done by the author in connection with corn grown for the Bowker prize in 1910. The proportions of corn and cob in dry matter in 10 representative ears of 9 varieties were determined with the following results: —

	Grain (Per Cent.).	Cob (Per Cent.).
1. Flint,	83.7	16.3
2. Flint,	84.8	15.2
3. Flint,	85.8	14.2
4. Flint,	78.7	21.3
5. Flint,	83.6	16.4
6. Flint,	84.6	15.4
Average,	83.5	16.5
7. Dent,	85.0	15.0
8. Dent,	80.7	19.3
9. Dent,	83.9	16.1
Average,	83.2	16.8

Composition of Grain and Cob.

During the seasons of 1908 and 1909 samples of corn kernels were analyzed with the following results: —

Analyses of Grain (Per Cent.).

[Dry Matter.]

Year.	Variety.	Condition.	Protein.	Fat.	Nitrogen-free Extract.	Fiber.	Ash.	Starch.
1909	Twitchell's,	Mature.	11.30	5.12	80.49	1.58	1.51	67.54
1908	Sanford White,	Mature.	10.92	5.22	80.83	1.53	1.50	71.35
1908	Longfellow,	Mature.	10.80	5.46	80.72	1.43	1.59	70.86
1908	Rustler,	Mature.	9.55	4.44	82.79	1.77	1.45	72.84
1909	Rustler,	Mature.	9.56	4.55	82.33	1.41	1.52	70.00
1909	Brewer's,	In milk.	9.64	3.97	81.99	2.70	1.70	67.27
1908	Early Mastodon,	In milk.	9.22	4.62	82.29	2.33	1.54	72.98
1909	Early Mastodon,	In milk.	9.69	4.36	82.06	2.21	1.68	68.39
1908	Klondike,	In milk.	10.81	4.40	80.73	2.27	1.79	71.48
1908	Red Cob Silage,	In milk.	10.69	3.61	81.80	2.33	1.57	72.70
1908	White Cap Yellow,	In milk.	10.30	3.93	82.13	2.09	1.55	73.13
1909	White Cap Yellow,	In milk.	9.06	4.42	82.77	2.24	1.51	69.16
1909	Wing's Improved White Cap,	In milk.	10.21	4.35	81.18	2.52	1.74	67.90

A study of the analytical results shows very slight variations in composition. The protein of the first varieties is

rather in excess of the Rustler Dent. The protein of the coarse, less mature dents would probably have been somewhat less had they been more completely matured. The fiber percentage is noticeably less in the mature lots, 1.54 as against 2.34 for the immature types. A high fiber is believed to be characteristic of immature corn. The percentages of starch are remarkably uniform.

While corn has been bred in an experimental way which bore decidedly different chemical characteristics (namely, high protein, high starch and high fat), such corn has not come into general use; when, therefore, the grain is grown primarily as a food for stock it is believed that the farmer can do no better than to grow the variety that will in his experience produce the largest number of bushels of mature corn per acre. This fact is borne out not only by the analyses herein reported, but also by others made by the author. Chemical composition cannot, at the present time, be considered a factor in the selection of seed corn where the crop is used for the sustenance of live stock.

An evident effect of the season upon the starch content is shown in the case of Rustler, Early Mastodon and White Cap Yellow, all grown in two successive years. In each case the starch content was slightly lower for 1909, an unfavorable year.

Analysis of Corn Cob (Per Cent.).
[Dry Matter.]

Year.	Variety.	Condition.	Protein.	Fat.	Nitrogen-free Extract.	Fiber.	Ash.
1908	Sanford White, . .	Mature.	1.97	.27	58.21	38 01	1.54
1908	Longfellow, . . .	Mature.	1.98	.30	59.11	36.91	1.70
1908	Rustler, ...	Mature.	1.70	.44	62.15	34.12	1.59
1908	Early Mastodon, . .	In milk.	1.84	.32	60.79	35.49	1.56
1908	Klondike, . . .	In milk.	2.21	.38	61.80	33.86	1 75
1908	Red Cob Silage, . .	In milk.	2.09	.38	60.07	35.75	1.75
1908	White Cap Yellow Dent,	In milk.	2.17	.34	60.08	35.98	1.49
	Average, . . .	–	1.99	.33	60.32	35.73	1 63

The above analyses represent the product of several varieties of cob produced during the season of 1908. One notes com-

paratively little variation in the composition. The cob is characterized by its very low protein and fat content and its high extract matter and fiber. It is doubtful if the cob from any number of different varieties would show substantial variations from the figures reported above. Lindsey and Holland [1] have shown the cob to contain over 30 per cent. of pentosans which have a digestibility of 63 per cent., and, further,[2] that the total dry matter of the cob has a digestibility of 59 per cent. So far as known, further studies of the chemical character of the extract matter have not been made. It is evident that the chief feeding value of the cob is to be found in its 59 per cent. of digestible carbohydrates.

On the basis of the work done by Kellner,[3] the net available energy in 100 pounds of cob containing 11 per cent. water is 40.2 therms, as against 85.5 therms in a like amount of corn meal; or 100 pounds of corn cob has 47 per cent. of the energy value of corn meal.

The practical feeder, therefore, cannot afford to pay grain prices for the cob when used as an adulterant of wheat-mixed feed, hominy meal or the like. Its use, however, is warranted when produced upon the farm and ground together with the kernel as a food for farm animals.

Summary.

Yield. — The small, early maturing types of corn are not economical for Massachusetts conditions; the medium dent and flint varieties that will mature in the average season are quite well suited for grain, and also serve fairly well for silage. The larger medium dent varieties that in an average season bring their ears to the milk stage are, all conditions considered, rather preferable for silage purposes, while the coarse, late maturing varieties, which never ripen seed in this locality, are not satisfactory because of the less net available energy produced (actual food value).

The season has a marked influence upon the yield of the corn crop, the same variety of corn under otherwise identical

[1] Fifteenth Rept. of the Hatch Exp. Sta., pp. 78–79.

[2] Eighteenth Rept. of the Hatch Exp. Sta., p. 243.

[3] Die Ernährung die Landw. Nützthiere, fünfte Auflage, pp. 159–169, also p. 601.

conditions yielding from 50 to 100 per cent. more in a year particularly favorable to its growth.

Composition of the Corn Plant. — The general conclusion can be drawn that the changes in chemical composition which the plant undergoes in its development are such that its maximum feeding value exists at its maturity.

Digestibility of the Corn Plant. — Digestion experiments conducted with the entire corn plant showed no wide variation in the digestibility of the several varieties, the range being from 67 to 77 per cent. With one exception the digestibility appeared to depend upon the percentage of nitrogen-free extract. The higher the percentage of extract or starchy matter present, the higher the digestibility.

Proportion and Composition of Parts. — The stalks and ears form practically 70 per cent. of the dry matter of the plant, the leaves and husks 30 per cent.

Relative Proportion of Grain to Cob. — The percentage of grain to cob varies widely, depending to some extent upon the maturity of the plant when cut. The average for the several mature types was 15.5 per cent. cob and 84.5 per cent. kernel, while the average for the less mature varieties was 18.1 per cent. cob and 81.9 per cent. kernel. In either case the percentage of cob was less than that of the Massachusetts legal bushel, which in the case of shelled corn is 56 pounds, and for ear corn 70 pounds, thus allowing 14 pounds, or 20 per cent., for cob.

Composition of Grain and Cob. — The grain analyzed showed only slight variations in composition. Chemical composition cannot at the present time be considered a factor in the selection of seed corn where the crop is used for the sustenance of live stock.

There appears to be very little variation in the composition of the corn cob. The net available energy in 100 pounds of cob, after the method of calculation suggested by Kellner, is 40.2 therms as against 85.5 therms in a like amount of corn meal; hence on this basis ground corn cob would have 47 per cent. of the energy value of corn meal.[1]

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[1] The Kellner method of calculation is the best we have for making comparative estimates of relative values.

THE DIGESTIBILITY OF CATTLE FOODS.

BY J. B. LINDSEY AND P. H. SMITH.

The digestion experiments herein reported were made during the autumn, winter and early spring of 1906–07, 1908–09 and 1909–10, and form part of what are known as Series XII., XIV. and XV. The experiments made in these series and not here included have been published in previous reports.

The usual method was employed and has been fully described elsewhere.[1] The full data are here presented, with the exception of the daily production of manure and the daily water consumption, in which cases, to economize space, averages only are given. The periods extended over fourteen days, the first seven of which were preliminary, collection of feces being made during the last seven. Ten grams of salt were given each sheep daily with water *ad libitum*.

Series XII.

Three lots of Southdown wethers were employed and were known as Old Sheep, Young Sheep and Paige Sheep. The former were fully seven years of age, and the latter two lots four to five years old.

The hay used in connection with the several experiments consisted of fine-mixed grasses, and contained a large proportion of June grass. The digestion coefficients of this hay as applied to the experiments in this series were obtained in 1905, and were as follows: —

[1] Eleventh report of the Mass. State Agr. Exp. Sta., pp. 146–149; also the 22d report of the Mass. Agr. Exp. Sta., p. 84.

Digestion Coefficients used in these Experiments.[1]

[English Hay.]

	Old Sheep II. and III.	Young Sheep I., II. and III.	Paige Sheep IV. and V.
Dry matter,	67.87	65.92	65.48
Ash,	49.17	51.95	44.60
Protein,	62.31	61.98	61.53
Fiber,	76.30	72.87	73.81
Nitrogen-free extract,	66.39	64.66	64.46
Fat,	52.37	54.23	50.20

Composition of Feedstuffs (Per Cent.).

[Dry Matter.]

	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Pride of the North corn fodder (entire plant),	4.07	7.69	17.96	67.62	2.66
Leaming corn fodder (entire plant),	4.69	7.89	22.42	62.94	2.06
English hay,	6.75	12.23	33.45	44.67	2.90
Biles Union grains,	6.67	27.11	10.55	47.45	8.22
Schumacher's stock feed,	4.44	11.73	11.70	67.31	4.82
Protena dairy feed,	7.28	19.56	20.16	49.92	3.08
Buffalo Creamery feed,	4.68	21.87	13.58	55.32	4.55
Waste, Paige Sheep, IV., Period I.,	3.77	8.70	14.28	69.92	3.33

Composition of Feces (Per Cent.).

[Dry Matter.]

Old Sheep II.

Period.	Feeds.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
I.	Pride of the North corn fodder,	10.21	11.74	27.77	48.65	1.63
VI.	Biles Union grains,	13.30	17.90	21.39	43.81	3.60

Old Sheep III.

II.	Leaming corn fodder,	9.67	10.90	28.21	49.49	1.73

[1] Made in 1905.

Composition of Feces (Per Cent.) — Concluded.

[Dry Matter.]

Young Sheep I.

Period.	Feeds.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
VIII.	Schumacher's stock feed,	11.58	13.62	24.06	47.40	3.34
XIII.	Buffalo Creamery feed,	10.07	13.59	25.17	47.61	3.56
	Young Sheep II.					
IX.	Biles Union grains,	11.32	17.33	22.28	45.71	3.36
	Young Sheep III.					
VIII.	Schumacher's stock feed,	11.63	12.95	25.14	46.91	3.37
XIII.	Buffalo Creamery feed,	10.03	13.62	25.14	47.87	3.34
	Paige Sheep IV.					
I.	Pride of the North corn fodder,	12.89	12.75	24.61	47.65	2.10
XII.	Protena dairy feed,	11.72	14.49	27.15	43.42	3.22
	Paige Sheep V.					
II.	Leaming corn fodder,	10.23	10.30	29.40	48.50	1.57
XII.	Protena dairy feed,	11.24	13.77	28.24	43.67	3.08

Dry Matter Determinations made at the Time of weighing out the Different Foods, and Dry Matter in Air-dry Feces (Per Cent.).

Old Sheep II.

Period.	English Hay.	Pride of the North Corn Fodder.	Leaming Corn Fodder.	Schumacher's Stock Feed.	Buffalo Creamery Feed.	Biles Union Grains.	Protena Dairy Feed.	Waste.	Feces.
I.	–	29.50	–	–	–	–	–	–	89.78
VI.	88.20	–	–	–	–	90.91	–	–	92.15
				Old Sheep III.					
II.	–	–	24.52	–	–	–	–	–	89.92
				Young Sheep I.					
VIII.	89.82	–	–	90.78	–	–	–	–	92.79
XIII.	90 65	–	–	–	90.55	–	–	–	94.48

Dry Matter Determinations made at the Time of weighing out the Different Foods, and Dry Matter in Air-dry Feces (Per Cent.) — Concluded.

Period.	English Hay.	Pride of the North Corn Fodder.	Leaming Corn Fodder.	Schumacher's Stock Feed.	Buffalo Creamery Feed.	Biles Union Grains.	Protena Dairy Feed.	Waste.	Feces.
Young Sheep II.									
IX.	89.82	–	–	–	–	92.57	–	–	92.34
Young Sheep III.									
VIII.	89.82	–	–	90.78	–	–	–	–	92.97
XIII.	90.65	–	–	–	90.55	–	–	–	94.26
Paige Sheep IV.									
I.	–	29.50	–	–	–	–	–	36.26	90.19
XII.	90.45	–	–	–	–	–	91.36	–	94.55
Paige Sheep V.									
II.	–	–	24.52	–	–	–	–	–	90.76
XII.	90.45	–	–	–	–	–	91.36	–	94.42

Average Daily Amount of Manure excreted and Water drunk (Grams).

Period.	Character of Food or Ration.	Manure excreted Daily.	One-tenth Manure Air-dry.	Water drunk Daily.
Old Sheep II.				
I.	Pride of the North corn fodder,	1,008	31.84	937
VI.	Biles Union grains,	751	25.63	1,899
Old Sheep III.				
II.	Leaming corn fodder,	795	28.64	893
Young Sheep I.				
VIII.	Schumacher's stock feed,	540	24.96	1,936
XIII.	Buffalo Creamery feed,	545	25.68	2,286
Young Sheep II.				
IX.	Biles Union grains,	770	25.41	2,271

Average Daily Amount of Manure excreted and Water drunk (Grams) — Concluded.

Young Sheep III.

Period.	Character of Food or Ration.	Manure excreted Daily.	One-tenth Manure Air-dry.	Water drunk Daily.
VIII.	Schumacher's stock feed, ...	528	25.32	2,185
XIII.	Buffalo Creamery feed, ...	551	25.32	2,179
	Paige Sheep IV.			
I.	Pride of the North corn fodder, . . .	613	20.03	1,101
XII.	Protena dairy feed, ...	823	26.36	1,364
	Paige Sheep V.			
II.	Leaming corn fodder, ...	1,143	29.91	1,050
XII.	Protena dairy feed, ...	769	27.03	1,764

Weights of Animals at Beginning and End of Period (Pounds).[1]

Old Sheep II.

Period.	Character of Food or Ration.	Beginning.	End.
I.	Pride of the North corn fodder, ...	110.0	111.0
VI.	Biles Union grains, ...	108.5	103.5
	Old Sheep III.		
II.	Leaming corn fodder, ...	113.5	125.5
	Young Sheep I.		
VIII.	Schumacher's stock feed, ...	102.0	101.5
XIII.	Buffalo Creamery feed, ...	102.0	100.0
	Young Sheep II.		
IX.	Biles Union grains, ...	93.5	89.0
	Young Sheep III.		
VIII.	Schumacher's stock feed, ...	94.5	92.5
XIII.	Buffalo Creamery feed, ...	92.0	93.0

[1] The weights of the sheep in several cases vary much more widely than would be expected, and it is possible that errors were made in recording them. In order to guard against this, weights for two consecutive days are now made at the beginning and end of each trial.

Weights of Animals at Beginning and End of Period (Pounds) — Concluded.

Paige Sheep IV.

Period.	Character of Food or Ration.	Beginning.	End.
I.	Pride of the North corn fodder,	121.5	116.5
XII.	Protena dairy feed,	124.5	122.5

Paige Sheep V.

Period.	Character of Food or Ration.	Beginning.	End.
II.	Leaming corn fodder,	108.0	110.0
XII.	Protena dairy feed,	119.0	112.0

Pride of the North Corn Fodder, Period I.

Old Sheep II.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
3,600 grams Pride of the North corn fodder fed daily.	1,062.00	43.22	81.67	190.74	718.12	28.25
318.41 grams manure excreted,	285.87	29.19	33.56	79.39	139.08	4.66
Grams digested,	776.13	14.03	48.11	111.35	579.04	23.59
Per cent. digested,	73.08	32.46	58.91	58.38	80.63	83.50

Paige Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
3,600 grams Pride of the North corn fodder fed daily.	1,062.00	43.22	81.67	190.74	718.12	28.25
335.4 grams waste,	121.62	4.59	10.58	17.37	85.04	4.05
Amount consumed,	940.38	38.63	71.09	173.37	633.08	24.20
200.26 grams manure excreted,	180.61	23.28	23.03	44.45	86.06	3.79
Grams digested,	759.77	15.35	48.06	128.92	547.02	20.41
Per cent. digested,	80.79	39.71	67.60	74.36	86.41	84.34
Average per cent. for both sheep,	76.94	36.10	63.26	66.37	83.52	83.92

Leaming Corn Fodder, Period II.

Old Sheep III.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
3,600 grams Leaming corn fodder fed,	882.72	41.40	69.65	197.91	555.58	18.18
286.43 grams manure excreted,	257.56	24.91	28.07	72.66	127.47	4.46
Grams digested,	625.16	16.49	41.58	125.25	428.11	13.72
Per cent. digested,	70.82	39.83	59.70	63.29	77.06	75.47

Leaming Corn Fodder, Period II — Concluded.

Paige Sheep V.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
3,600 grams Leaming corn fodder fed,	882.72	41.40	69.65	197.91	555.58	18.18
299.08 grams manure excreted,	271.45	27.77	27.96	79.81	131.65	4.26
Grams digested,	611.27	13.63	41.69	118.10	423.93	13.92
Per cent. digested,	69.25	32.92	59.86	59.67	76.30	76.57
Average per cent. for both sheep,	70.04	36.38	59.78	61.48	76.68	76.02

Biles Union Grains, Period VI.

Old Sheep II.

650 grams English hay fed,	573.30	38.70	70.11	191.77	256.09	16.63
250 grams Biles Union grains fed,	227.28	15.16	61.62	23.98	107.84	18.68
Amount consumed,	800.58	53.86	131.73	215.75	363.93	35.31
256.76 grams manure excreted,	236.60	31.47	42.35	50.61	103.65	8.52
Grams digested,	563.98	22.39	89.38	165.14	260.28	26.79
Minus hay digested,	389.10	19.03	43.69	146.32	170.02	8.71
Biles Union grains digested,	174.88	3.36	45.69	18.82	90.26	18.08
Per cent. digested,	76.94	22.16	74.15	78.48	83.70	96.79

Biles Union Grains, Period IX.

Young Sheep II.

600 grams English hay fed,	538.92	36.38	65.91	180.27	240.74	15.63
200 grams Biles Union grains fed,	185.14	12.35	50.19	19.53	87.85	15.22
Amount consumed,	724.06	48.73	116.10	199.80	328.59	30.85
254.10 grams manure excreted,	234.86	26.59	40.70	52.33	107.35	7.89
Grams digested,	489.20	22.14	75.40	147.47	221.24	22.96
Minus hay digested,	355.26	18.90	40.85	131.36	155.66	8.48
Biles Union grains digested,	133.94	3.24	34.55	16.11	65.58	14.48
Per cent. digested,	72.35	26.23	68.84	82.49	74.65	95.14

Schumacher's Stock Feed, Period VIII.

Young Sheep I.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
550 grams English hay fed,	494.01	33.35	60.42	165.25	220.67	14.33
250 grams Schumacher's stock feed fed,	226.95	10.08	26.62	26.55	152.76	10.94
Amount consumed,	720.96	43.43	87.04	191.80	373.43	25.27
249.61 grams manure excreted,	231.64	26.82	31.55	55.73	109.80	7.74
Grams digested,	489.32	16.61	55.49	136.07	263.63	17.53
Minus hay digested,	325.65	17.33	37.45	120.42	142.69	7.77
Schumacher's stock feed digested,	163.67	–	18.04	15.65	120.94	9.76
Per cent. digested,	72.12	–	67.77	58.95	79.17	89.21

Young Sheep III.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above,	720.96	43.43	87.04	191.80	373.43	25.27
253.20 grams manure excreted,	235.40	27.38	30.48	59.18	110.43	7.93
Grams digested,	485.56	16.05	56.56	132.62	263.00	17.34
Minus hay digested,	325.65	17.33	37.45	120.42	142.69	7.77
Schumacher's stock feed digested,	159.91	–	19.11	12.20	120.31	9.57
Per cent. digested,	70.46	–	71.79	45.95	78.76	87.48
Average per cent. for both sheep,	71.29	–	69.78	52.45	78.97	88.35

Protena Dairy Feed, Period XII.

Paige Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
600 grams English hay fed,	542.70	36.63	66.37	181.53	242.42	15.74
200 grams Protena dairy feed fed,	182.72	13.30	35.74	36.84	91.21	5.63
Amount consumed,	725.42	49.93	102.11	218.37	333.63	21.37
263.57 grams manure excreted,	249.21	29.21	36.11	67.66	108.21	8.02
Grams digested,	476.21	20.72	66.00	150.71	225.42	13.35
Minus hay digested,	355.36	16.34	40.84	133.99	156.26	7.90
Protena dairy feed digested,	120.85	4.38	25.16	16.72	69.16	5.45
Per cent. digested,	66.14	32.93	70.40	45.39	75.83	96.80

Protena Dairy Feed, Period XII — Concluded.

Paige Sheep V.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above,	725.42	49.93	102.11	218.37	333.63	21.37
270.27 grams manure excreted,	255.19	28.68	35.14	72.07	111.44	7.86
Grams digested,	470.23	21.25	66.97	146.30	222.19	13.51
Minus hay digested,	355.36	16.34	40.84	133.99	156.26	7.90
Protena dairy feed digested,	114.87	4.91	26.13	12.31	65.93	5.61
Per cent. digested,	62.87	36.92	73.11	33.41	72.29	99.64
Average per cent. for both sheep,	64.51	34.93	71.76	39.40	74.06	98.22

Buffalo Creamery Feed, Period XIII.

Young Sheep I.

600 grams English hay fed,	543.90	36.71	66.52	181.93	242.96	15.77
200 grams Buffalo Creamery feed fed,	181.10	8.48	39.61	24.59	100.18	8.24
Amount consumed,	725.00	45.19	106.13	206.52	343.14	24.01
256.84 grams manure excreted,	242.66	24.44	32.98	61.08	115.53	8.64
Grams digested,	482.34	20.75	73.15	145.44	227.61	15.37
Minus hay digested,	358.54	19.07	41.23	132.57	157.10	8.55
Buffalo Creamery feed digested,	123.80	1.68	31.92	12.87	70.51	6.82
Per cent. digested,	68.36	19.81	80.59	52.34	70.38	82.77

Young Sheep III.

Amount consumed as above,	725.00	45.19	106.13	206.52	343.14	24.01
253.23 grams manure excreted,	238.69	23.94	32.51	60.01	114.26	7.97
Grams digested,	486.31	21.25	73.62	146.51	228.88	16.04
Minus hay digested,	358.54	19.07	41.23	132.57	157.10	8.55
Buffalo Creamery feed digested,	127.70	2.18	32.39	13.94	71.78	7.49
Per cent. digested,	70.55	25.71	81.77	56.69	71.65	90.90
Average per cent. for both sheep,	69.46	22.76	81.18	54.52	71.02	86.84

Summary of Coefficients (Per Cent.).

Food.	Sheep Number.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Pride of the North corn fodder,	Old Sheep II.,	73.08	32.46	58.91	58.38	80.63	83.50
	Paige Sheep IV.,	80.79	39.74	67.60	74.36	86.41	84.34
Average,	– –	76.94	36.10	63.26	66.37	83.52	83.92
Leaming corn fodder,	Old Sheep III.,	70.82	39.83	59.70	63.29	77.06	75.47
	Paige Sheep V.,	69.25	32.92	59.86	59.67	76.30	76.57
Average,	– –	70.04	36.38	59.78	61.48	76.68	76.02
Biles Union grains,	Old Sheep II.,	76.94	22.16	74.15	78.48	83.70	96.79
	Young Sheep II.,	72.35	26.23	68.84	82.49	74.65	95.14
Average,	– –	74.65	24.20	71.50	80.49	79.18	95.97
Schumacher's stock feed,	Young Sheep I.,	72.12	–	67.77	58.95	79.17	89.21
	Young Sheep III.,	70.46	–	71.79	45.95	78.76	87.48
Averago,	– –	71.29	–	69.78	52.45	78.97	88.35
Protena dairy feed,	Paige Sheep IV.,	66.14	32.93	70.40	45.39	75.83	96.80
	Paige Sheep V.,	62.87	36.92	73.11	33.41	72.29	99.64
Average,	– –	64.51	34.93	71.76	39.40	74.06	98.22
Buffalo Creamery feed,	Young Sheep I.,	68.36	19.81	80.59	52.34	70.38	82.77
	Young Sheep III.,	70.55	25.71	81.77	56.69	71.65	90.90
Average,	– –	69.46	22.76	81.18	54.52	71.02	86.84

Discussion of the Results.

The most important results obtained from the experiments reported in the previous pages are discussed under the following headings: —

Pride of the North Corn Fodder. — The fodder used was of excellent quality and exceptionally well eared. The one-twentieth acre plot on which it was grown yielded at the rate of slightly over 21 tons to the acre and contained 49 per cent. of ears in dry matter. The unusually high percentage of ears naturally increased the digestibility of the fodder. The corn was cut from the field every two days, the first cutting being September 5, and the last September 19. The entire plant was finely cut before being fed, dry matter determinations being made of each single cutting.

Summary of Coefficients, Period I. (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Old Sheep II.,	1	1	73.08	32.46	58.91	58.38	80.63	83.50
Paige Sheep IV.,	1	1	80.79	39.74	67.60	74.36	86.41	84.34
Average,	1	2	76.94	36.10	63.26	66.37	83.52	83.92
Average of all experiments, mature dent corn fodder for comparison.	12	23	69.00	34.00	54.00	59.00	75.00	75.00

Paige Sheep IV. gave higher results than did Old Sheep II., probably due in part to the fact that the former left a portion of the tougher and less digestible part. The present experiment shows in a fairly satisfactory manner the digestibility of a variety of dent corn that will mature in Massachusetts, and also emphasizes the fact that a fodder containing a higher percentage of ears is noticeably more digestible than one containing relatively fewer ears and a larger percentage of stalk.

Leaming Corn Fodder. — The fodder used was fed at the same time and handled in the same manner as was the preceding variety. The one-twentieth acre plot yielded at the rate of 25½ tons per acre. The crop contained 31 per cent. of ears in dry matter. The stalks are rather larger than the Pride of the North, and in the average season the Leaming matures a little later.

Summary of Coefficients, Period II. (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Old Sheep III.,	1	1	70.82	39.83	59.70	63.29	77.06	75.47
Paige Sheep V.,	1	1	69.25	32.92	59.86	59.67	76.30	76.57
Average,	1	2	70.04	36.38	59.78	61.48	76.68	76.02
Average all experiments, mature dent corn fodder for comparison.	12	23	69.00	34.00	54.00	59.00	75.00	75.00

The sheep consumed the entire ration fed. The coefficients for both sheep agreed closely, not only with each other, but also with the average of all experiments with dent fodder. The Leaming is shown to be rather less digestible than the Pride of the North, due to its rather coarser stalks and to its relatively less ear production. It is believed, however, that this variety of dent fodder is quite well suited for silage in Massachusetts.

Biles Union Grains. — Biles Union Grains is a proprietary feed consisting principally of a mixture of distillers' dried grains and malt sprouts, together with some corn and wheat products, cottonseed meal and salt. The amount of its several components is likely to vary more or less from time to time, depending upon the feeding stuffs available and their cost. This variation in composition varies its digestibility within narrow limits. It is intended, when fed with home-grown roughage, to constitute a balanced ration for dairy stock.

Summary of Coefficients, Periods VI. and IX. (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Old Sheep II.,	1	1	76.94	22.16	74.15	78.48	83.70	96.79
Young Sheep II.,	1	1	72.35	26.23	68.84	82.49	74.56	95.14
Average,	1	2	74.65	24.20	71.50	80.49	79.18	95.97

The coefficients agree fairly well, although the Young Sheep II. did not appear to digest the nitrogen-free extract as well as did Old Sheep II. The feed can be considered fairly digestible.

Schumacher's Stock Feed. — This material consists of a mixture of corn, oat and barley residues resulting from the manufacture of human foods from these cereals. It contains about 10 per cent. protein, 3.50 per cent. fat and 9 per cent. fiber. It is extensively advertised as a food for horses and dairy stock.

Summary of Coefficients, Period VIII. (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Young Sheep I., ...	1	1	72.12	–	67.77	58.95	79.17	89.21
Young Sheep II., ...	1	1	70.46	–	71.79	45.95	78.76	87.48
Average, ...	1	2	71.29	–	69.78	52.45	78.97	88.35
Oats, unground, for comparison, .	2	6	70.00	–	77.00	31.00	77.00	89.00

The coefficients obtained for both sheep with the exception of that for fiber agree satisfactorily. The digestibility as well as the composition of this feed resembles that of oats, for which it is often substituted in feeding horses. When used for this purpose it would be advisable to moisten it because of its fine and dry condition.

Protena Dairy Feed. — This material is no longer found in the Massachusetts market. It was composed of ground alfalfa as a basis, together with cottonseed meal, wheat by-products and salt.

Summary of Coefficients, Period XII. (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Paige Sheep IV., ...	1	1	66.14	32.93	70.40	45.39	75.83	96.80
Paige Sheep V., ...	1	1	62.87	36.92	73.11	33.41	72.29	99.64
Average, ...	1	2	64.51	34.93	71.76	39.40	74.06	98.22

The presence of so much alfalfa gave it a relatively high fiber content, and a low fiber digestibility. The digestibility of the entire foodstuff is decidedly below the minimum desired for a high-grade concentrate, due also to the large amount of alfalfa used.

Buffalo Creamery Feed. — This is a proprietary mixture containing about 20 per cent. protein, 5 per cent. fat and 9 per

cent. fiber. According to the manufacturer's guarantee it contains corn, wheat middlings, oat hulls, hominy feed, cottonseed meal and gluten feed.

Summary of Coefficients, Period XIII. (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Young Sheep I.,	1	1	68.36	19.81	80.59	52.34	70.38	82.77
Young Sheep III.,	1	1	70.55	25.71	81.77	56.69	71.65	90.90
Average,	1	2	69.46	22.76	81.18	54.52	71.02	86.84

The coefficients agree closely, and the feed approaches the minimum degree of digestibility (70 per cent.) for a concentrate. Its protein digestibility is fairly satisfactory. Its economy as a dairy feed would naturally depend upon its cost. Feeds of this character are likely to cost more than the ingredients of which they are composed.

Series XIV.

Eleven experiments were made in this series, all of which, with the exception of the 4 that follow, were carried out with Porto Rico molasses and are published elsewhere. The digestion coefficients for the hay used in periods VIII. and X. were those obtained in period XI. The 4 sheep used in this experiment were yearling Shropshires of substantially uniform weight.

Composition of Feedstuffs (Per Cent.).

[Dry Matter.]

Feeds.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
English hay,	6.82	7.67	30.35	52.79	2.37
Early Mastodon Dent corn fodder.	4.31	7.38	19.40	66.74	2.17
Rustler White Dent corn fodder,	4.38	6.87	19.46	66.96	2.33
Unicorn dairy ration,	3.60	29.61	9.76	50.11	6.92
Waste, Sheep IV., period II.,	2.85	3.37	29.12	63.58	1.08

Composition of Feces (Per Cent.).

[Dry Matter.]

Sheep I.

Period.	Feeds.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
I.	Early Mastodon Dent corn fodder,	9.52	11.12	27.34	50.57	1.45
VIII.	Unicorn dairy ration, . . .	10.55	15.61	24.37	46.56	2.91
X.	Unicorn dairy ration, . . .	11.64	13.63	25.18	46.47	3.08
XI.	English hay, ...	11.16	10.65	27.78	46.91	3.50

Sheep II.

Period.	Feeds.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
I.	Early Mastodon Dent corn fodder,	10.16	11.41	27.70	49.17	1.56
VIII.	Unicorn dairy ration, . . .	11.01	14.66	25.32	46.14	2.87
XI.	English hay, ...	10.45	10.17	29.55	46.65	3.18

Sheep III.

Period.	Feeds.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
II.	Rustler White Dent corn fodder, .	9.77	12.07	26.62	49.87	1.67

Sheep IV.

Period.	Feeds.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
II.	Rustler White Dent corn fodder, .	11.17	14.11	25.11	47.61	1.99

Dry Matter Determinations made at the Time of weighing out the Different Foods, and Dry Matter in Air-dry Feces (Per Cent.).

Sheep I.

Period.	English Hay.	Early Mastodon Dent Corn Fodder.	Rustler White Dent Corn Fodder.	Unicorn Dairy Ration.	Waste.	Feces.
I., ...	–	24.80	–	–	–	89.08
VIII., ...	89.45	–	–	91.11	–	93.36
X., ...	90.22	–	–	92.46	–	93.52
XI., ...	90.05	–	–	–	–	93.41

Sheep II.

Period.	English Hay.	Early Mastodon Dent Corn Fodder.	Rustler White Dent Corn Fodder.	Unicorn Dairy Ration.	Waste.	Feces.
I., ...	–	24.80	–	–	–	88.92
VIII., ...	89.45	–	–	91.11	–	93.27
XI., ...	90.05	–	–	–	–	93.49

Dry Matter Determinations made at the Time of weighing out the Different Foods, and Dry Matter in Air-dry Feces (Per Cent.) — Concluded.

Sheep III.

Period.	English Hay.	Early Mastodon Dent Corn Fodder.	Rustler White Dent Corn Fodder.	Unicorn Dairy Ration.	Waste.	Feces.
II., ...	–	–	31.46	–	–	88.51

Sheep IV.

Period.	English Hay.	Early Mastodon Dent Corn Fodder.	Rustler White Dent Corn Fodder.	Unicorn Dairy Ration.	Waste.	Feces.
II., ...	–	–	31.46	–	94.05	88.64

Average Daily Amount of Manure excreted and Water Drunk (Grams).

Sheep I.

Period.	Character of Food or Ration.	Manure excreted Daily.	One-tenth Manure Air-dry.	Water drunk Daily.
I.	Early Mastodon Dent corn fodder, . .	594	18.62	404
VIII.	Unicorn dairy ration, ...	1,000	21.97	2,325
X.	Unicorn dairy ration, ...	751	23.97	2,493
XI.	English hay, ...	633	24.55	2,292

Sheep II.

Period.	Character of Food or Ration.	Manure excreted Daily.	One-tenth Manure Air-dry.	Water drunk Daily.
I.	Early Mastodon Dent corn fodder, . .	733	18.99	416
VIII.	Unicorn dairy ration, ...	891	21.85	2,500
XI.	English hay, ...	722	26.62	2,251

Sheep III.

Period.	Character of Food or Ration.	Manure excreted Daily.	One-tenth Manure Air-dry.	Water drunk Daily.
II.	Rustler White Dent corn fodder, . . .	929	26.67	1,889

Sheep IV.

Period.	Character of Food or Ration.	Manure excreted Daily.	One-tenth Manure Air-dry.	Water drunk Daily.
II.	Rustler White Dent corn fodder, . . .	1,184	24.15	904

Weights of Animals at Beginning and End of Period (Pounds).

Sheep I.

Period.	Character of Food or Ration.	Beginning.	End.
I.	Early Mastodon Dent corn fodder,	89.0	89.0
VIII.	Unicorn dairy ration,	86.5	87.5
X.	Unicorn dairy ration,	86.0	88.0
XI.	English hay,	90.0	88.5

Sheep II.

I.	Early Mastodon Dent corn fodder,	86.5	86.0
VIII.	Unicorn dairy ration,	87.5	87.0
XI.	English hay,	90.5	88.5

Sheep III.

II.	Rustler White Dent corn fodder,	85.5	90.0

Sheep IV.

II.	Rustler White Dent corn fodder,	97.0	95.0

Early Mastodon Dent Corn Fodder, Period I.

Sheep I.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
2,400 grams Mastodon corn fodder fed,	595.20	25.67	43.93	115.47	397.21	12.92
186.21 grams manure excreted (air-dry),	165.88	15.79	18.45	45.35	83.88	2.41
Grams digested,	429.32	9.88	25.48	70.12	313.33	10.51
Per cent. digested,	72.13	38.49	58.00	60.73	78.88	81.35

Sheep II.

2,400 grams Mastodon corn fodder fed,	595.20	25.67	43.93	115.47	397.21	12.92
189.90 grams manure excreted (air-dry),	168.86	17.16	19.27	46.77	83.03	2.63
Grams digested,	426.34	8.51	24.66	68.70	314.18	10.29
Per cent. digested,	71.63	33.15	56.13	59.50	79.10	79.64
Average per cent. for both sheep,	71.88	35.82	57.07	60.12	78.99	80.50

Rustler White Dent Corn Fodder, Period II.

Sheep III.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
2,400 grams Rustler corn fodder fed,	755.04	33.07	51.87	146.93	505.56	17.59
266.74 grams manure excreted (air-dry),	236.09	23.07	28.50	62.85	117.72	3.93
Grams digested,	518.95	10.00	23.37	84.08	387.84	13.66
Per cent. digested,	68.73	30.24	45.05	57.22	76.71	77.66

Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
2,400 grams Rustler corn fodder fed,	755.04	33.07	51.87	146.93	505.56	17.59
37.86 grams waste,	35.61	1.01	1.20	10.37	22.65	.38
Amount consumed,	719.43	32.06	50.67	136.56	482.91	17.21
241.53 grams manure excreted,	214.09	23.91	30.21	53.76	101.95	4.26
Grams digested,	505.34	8.15	20.46	82.80	380.96	12.95
Per cent. digested,	70.24	25.42	40.38	60.63	78.89	75.25
Average per cent. for both sheep,	69.49	27.83	42.72	58.93	77.80	76.46

Unicorn Dairy Ration, Period VIII.

Sheep I.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
500 grams English hay fed,	447.35	30.51	34.31	135.77	236.21	10.55
200 grams Unicorn dairy ration fed,	182.22	6.56	53.96	17.78	91.31	12.61
Amount consumed,	629.57	37.07	88.27	153.55	327.52	23.16
219.65 grams manure excreted (air-dry),	205.07	21.63	32.01	49.98	95.48	5.97
Grams digested,	424.50	15.44	56.26	103.57	232.04	17.19
Minus hay digested,	277.36	12.81	16.81	90.97	153.54	5.17
Unicorn dairy ration digested,	147.14	2.63	39.45	12.60	78.50	12.02
Per cent. digested,	80.74	40.09	73.11	70.87	85.97	95.32

Sheep II.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Amount consumed as above,	629.57	37.07	88.27	153.55	327.52	23.16
218.50 grams manure excreted (air-dry),	203.79	22.44	29.87	51.60	94.03	5.85
Grams digested,	425.78	14.63	58.40	101.95	233.49	17.31
Minus hay digested,	277.36	12.81	16.81	90.97	153.54	5.17
Unicorn dairy ration digested,	148.42	1.82	41.59	10.98	79.95	12.14
Per cent. digested,	81.45	27.74	77.07	61.75	87.55	96.27
Average per cent. for both sheep,	81.10	33.92	75.09	66.31	86.76	95.80

Unicorn Dairy Ration, Period X.

Sheep I.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
600 grams English hay fed,	541.32	36.92	41.52	164.29	285.73	12.86
150 grams Unicorn dairy ration fed,	138.69	4.98	41.07	13.54	69.50	9.60
Amount consumed,	680.01	41.90	82.59	177.83	355.23	22.46
239.67 grams manure excreted (air-dry),	224.14	26.09	30.55	56.44	104.16	6.90
Grams digested,	455.87	15.81	52.04	121.49	251.07	15.56
Minus hay digested,	335.62	15.51	20.34	110.07	185.72	6.30
Unicorn dairy ration digested,	120.25	.30	31.70	11.42	65.35	9.26
Per cent. digested,	86.70	6.02	77.19	84.34	94.03	96.46

English Hay, Period XI.

Sheep I.

700 grams English hay fed,	630.35	44.82	48.85	205.74	315.24	15.70
245.46 grams manure excreted (air-dry),	229.28	25.59	24.42	63.69	107.56	8.02
Grams digested,	401.07	19.23	24.43	142.05	207.68	7.68
Per cent. digested,	63.63	42.91	50.01	69.04	65.88	48.92

Sheep II.

700 grams English hay fed,	630.35	44.82	48.85	205.74	315.24	15.70
266.16 grams manure excreted (air-dry),	248.83	26.00	25.31	73.53	116.08	7.91
Grams digested,	381.52	18.82	23.54	132.21	199.16	7.79
Per cent. digested,	60.53	41.99	48.19	64.27	63.18	49.62
Average per cent. for both sheep,	62.08	42.45	49.10	66.66	64.53	49.27

Summary of Coefficients (Per Cent.).

Food.	Sheep Number.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Early Mastodon Dent corn fodder,	Sheep I.,	72.13	38.49	58.00	60.73	78.88	81.35
	Sheep II.,	71.63	33.15	56.13	59.50	79.10	79.64
Average,		71.88	35.82	57.07	60.12	78.99	80.50
Rustler White Dent corn fodder,	Sheep III.,	68.73	30.24	45.05	57.22	76.71	77.66
	Sheep IV.,	70 24	25.42	40.38	60.63	78.89	75.25
Average,		69.49	27.83	42.72	58.93	77.80	76.46
Unicorn dairy ration,	Sheep I.,	80.74	40.09	73.11	70.87	85.97	95.32
	Sheep I.,	86.70	6.02	77.19	84.34	94.03	96.46
	Sheep II.,	81.45	27.74	77.07	61.75	87.55	96.27
Average,		82.96	24.62	75.79	72.32	89.18	96.02
English hay,	Sheep I.,	63.63	42.91	50.01	69.04	65.88	48.92
	Sheep II.,	60.53	41.99	48.19	64.27	63.18	49.62
Average,		62.08	42.45	49.10	66.66	64.53	49.27

Discussion of the Results.

Early Mastodon Dent Corn Fodder. — This is a large growing yellow dent variety bred by C. S. Clark of Ohio. It is evidently rather too late for the average Massachusetts season. At the time of cutting (September 5–19) it was in the milk-to-denting stage, and could not be considered ripe enough to be cut for the grain. It yielded about 20 tons to the acre of green fodder which contained 28 per cent. of ears in dry matter.

Summary of Coefficients, Period I. (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Sheep I.,	1	1	72.13	38.49	58.00	60.73	78.88	81.35
Sheep II.,	1	1	71.63	33.15	56.13	59.50	79.10	79.64
Average,	1	2	71.88	35.82	57.07	60.12	78.99	80.50
Average of all experiments, dent fodder for comparison.	12	23	69.00	34.00	54.00	59.00	75.00	75.00

The results obtained in this trial were very satisfactory. They also agreed quite closely with the average for all trials for dent corn.

Rustler White Dent Corn Fodder. — So far as known this variety of corn originated in Minnesota; it was first grown at the Massachusetts Agricultural Experiment Station, where it has given excellent satisfaction. At the time of cutting (September 5–19) it was dented and glazing and ready to harvest. It yielded about 12 tons of green fodder which contained 41 per cent. of ears in dry matter. The yield was not so large as on other fields nearby. The tendency of this variety is to mature in our latitude and yield a fair amount of stalk with a relatively high grain percentage.

Summary of Coefficients, Period II. (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Sheep III.,	1	1	68.73	30.24	45.05	57.22	76.71	77.66
Sheep IV.,	1	1	70.24	25.42	40.38	60.63	78.89	75.25
Average,	1	2	69.49	27.83	42.72	58.93	77.80	76.46
Average of all experiments, dent fodder for comparison.	12	23	69.00	34.00	54.00	59.00	75.00	75.00

While the coefficients obtained in this experiment agreed closely, the digestibility was not as great as would naturally be expected, considering the percentage of ears and degree of maturity. This may be due, in part at least, to the fact that this corn was comparatively dry when cut, and the animals were fed rather more dry matter than was intended; in fact, more than they could readily care for. Sheep IV. left a part of the daily ration. With a smaller amount of dry matter in the ration, the coefficients might have been somewhat higher.

Unicorn Dairy Ration. — This is a proprietary mixture consisting of corn, distillers' grains, cottonseed meal, hominy feed, barley feed and sprouts and wheat bran. It contained on a natural moisture basis about 26 per cent. protein, 6 per cent. fat and 9 per cent. fiber.

Summary of Coefficients, Periods VIII. and X. (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Sheep I.,	1	1	80.74	40.09	73.11	70.87	85.97	95.32
Sheep II.,	1	1	81.45	27.74	77.07	61.75	87.55	96.27
Sheep I.,	1	1	86.07	6.02	77.19	84.34	94.03	96.46
Average,	1	2	81.10	33.92	75 09	66.31	86.76	95.80

The results secured in case of Sheep I. in period X. are noticeably above those for the other two trials, and it is thought best not to include them in the average. The reason for this variation cannot be explained. The coefficients for Sheep I. and II. in period VIII. agree fairly well, and show this proprietary feed to have a high digestibility. These results, together with its high protein and a low fiber content, indicate a high-grade protein dairy feed.

English Hay. — The hay used in this period consisted of mixed grasses with June grass predominating. It was cut while in blossom, well cured and in good condition. Before feeding it was cut fine by running it through a feed cutter, and thoroughly mixed to insure uniformity through the entire lot.

Summary of Coefficients, Period XI. (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Sheep I.,	1	1	63.63	42.91	50.01	69.04	65.88	48.92
Sheep II.,	1	1	60.53	41.99	48.19	64.24	63.18	49.62
Average,	1	2	62.08	42.45	49.10	66.66	64.53	49.27
Average of all trials, similar hay for comparison.	21	73	61.00	47.00	57.00	62.00	62.00	50.00

The coefficients obtained in this trial agree closely. With the exception of the coefficient obtained for protein they also

agree closely with the average of all results obtained with similar hay.

Series XV.

This series of experiments was conducted during the fall and winter of 1909–10. Those not reported concerned the effect of lactic acid and calcium lactate upon digestibility, and will be published at a later date. The sheep used were the same as for the preceding year.

Composition of Feedstuffs (Per Cent.).

[Dry Matter.]

Period.	Feeds.	Ash.	Protein.	Fiber.	Nitrogen-free Extract Matter.	Fat.
I.	Brewer's Dent corn fodder, . . .	5.32	9.84	23.94	59.40	1.50
II.	Wing's Improved White Dent corn fodder,	4.85	9.36	22.58	61.64	1.57
III.	Alfalfa hay, first cutting, third-year growth,	7.55	16.62	30.16	43.78	1.89
IV.	Alfalfa hay, second cutting, third-year growth.	6.70	15.31	38.03	38.67	1.29
V.	Alfalfa hay, first cutting, first-year growth,	7.63	16.49	35.28	39.10	1.50
VI.	Clover, second cutting, ...	8.96	15.28	29.76	44.12	1.88
VII.	Clover, first cutting, ...	11.22	17.82	28.30	40.70	1.96

Composition of Feces (Per Cent.).

Sheep I.

I.	Brewer's Dent corn fodder, . . .	10.00	11.27	25.93	51.17	1.63
III.	Alfalfa hay, first cutting, third-year growth,	10.13	11.35	43.90	31.33	3.29
V.	Alfalfa hay, first cutting, first-year growth,	10.41	11.01	45.14	30.87	2.57
VII.	Clover hay, first cutting, ...	12.26	18.09	30.28	36.75	2.62

Sheep II.

I.	Brewer's Dent corn fodder, . . .	10.50	10.87	27.75	49.08	1.80
III.	Alfalfa hay, first cutting, third-year growth,	10.70	10.74	44.82	30.74	3.00
V.	Alfalfa hay, first cutting, first-year growth,	10.34	11.04	44.99	30.86	2.77
VII.	Clover hay, first cutting, ...	12.14	17.23	32.45	35.68	2.50

Sheep III.

II.	Wing's Improved White Cap corn fodder, .	9.96	11.66	28.33	48.54	1.51
IV.	Alfalfa hay, second cutting, third-year growth.	9.47	10.23	48.09	29.78	2.43
VI.	Clover hay, second cutting, . . .	9.87	14.78	40.15	33.19	2.01

Composition of Feces (Per Cent.) — Concluded.

Sheep IV.

Period.	Feeds.	Ash.	Protein.	Fiber.	Nitrogen-free Extract Matter.	Fat.
II.	Wing's Improved White Cap corn fodder, .	9.99	11.73	25.08	51.55	1.65
IV.	Alfalfa hay, second cutting, third-year growth.	9.50	9.68	48.46	29.79	2.57
VI.	Clover hay, second cutting, . . .	9.73	15.56	38.93	33.63	2.15

Dry Matter Determinations made at the Time of weighing out the Different Foods, and Dry Matter in Air-dry Feces (Per Cent.).

Sheep I.

Period.	Brewer's Dent Corn Fodder.	Wing's Improved Dent Corn Fodder.	Alfalfa Hay, First Cutting, Third-year Growth.	Alfalfa Hay, First Cutting, First-year Growth.	Alfalfa Hay, Second Cutting, Third-year Growth.	Clover Hay, First Cutting.	Clover Hay, Second Cutting.	Feces.
I., . .	19.39	–	–	–	–	–	–	89.59
III., . .	–	–	85.42	–	–	–	–	91.53
V., . .	–	–	–	86.97	–	–	–	93.88
VII., . .	–	–	–	–	–	88.65	–	93.12
Sheep II.								
I., . .	19.39	–	–	–	–	–	–	89.71
III., . .	–	–	85.42	–	–	–	–	91.62
V., . .	–	–	–	86.97	–	–	–	93.87
VII., . .	–	–	–	–	–	88.65	–	93.22
Sheep III.								
II., . .	–	19.18	–	–	–	–	–	89.17
IV., . .	–	–	–	–	86.75	–	–	93.51
VI., . .	–	–	–	–	–	–	88.10	93.05
Sheep IV.								
II., . .	–	19.18	–	–	–	–	–	89.72
IV., . .	–	–	–	–	87.90	–	–	93.37
VI., . .	–	–	–	–	–	–	88.10	93.21

Average Daily Amount of Manure excreted and Water drunk (Grams).

Sheep I.

Period.	Character of Food or Ration.	Manure excreted Daily.	One-tenth Manure Air-dry.	Water drunk Daily.
I.	Brewer's Dent corn fodder, ...	403	29.21[1]	262
III.	Alfalfa hay, first cutting, third-year growth, .	563	22.21	1,737
V.	Alfalfa hay, first cutting, first-year growth, .	906	33.06	2,451
VII.	Clover hay, first cutting, ...	807	27.05	2,646

Sheep II.

Period.	Character of Food or Ration.	Manure excreted Daily.	One-tenth Manure Air-dry.	Water drunk Daily.
I.	Brewer's Dent corn fodder, ...	407	30.91[1]	224
III.	Alfalfa hay, first cutting, third-year growth, .	749	26.03	1,969
V.	Alfalfa hay, first cutting, first-year growth, .	724	29.83	2,475
VII.	Clover hay, first cutting, ...	721	28.48	2,656

Sheep III.

Period.	Character of Food or Ration.	Manure excreted Daily.	One-tenth Manure Air-dry.	Water drunk Daily.
II.	Wing's Improved White Cap fodder, . .	560	32.42[1]	157
IV.	Alfalfa hay, second cutting, third-year growth.	944	31.80	2,261
VI.	Clover hay, second cutting, ...	972	31.85	2,562

Sheep IV.

Period.	Character of Food or Ration.	Manure excreted Daily.	One-tenth Manure Air-dry.	Water drunk Daily.
II.	Wing's Improved White Cap fodder, . .	372	31.11[1]	95
IV.	Alfalfa hay, second cutting, third-year growth.	779	28.60	1,841
VI.	Clover hay, second cutting, . . .	675	29.26	2,453

Weights of Animals at Beginning and End of Periods (Pounds).

Sheep I.

Period.	Character of Food or Ration.	Beginning.	End.
I.	Brewer's Dent corn fodder, ...	94.50	93.25
III.	Alfalfa hay, first cutting, third-year growth, . .	99.50	97.25
V.	Alfalfa hay, first cutting, first-year growth, . .	101.25	100.00
VII.	Clover hay, first cutting, ...	97.25	100.00

[1] One-fifth of daily amount excreted.

Weights of Animals at Beginning and End of Periods (Pounds) — Concluded.

Sheep II.

Period.	Character of Food or Ration.	Beginning.	End.
I.	Brewer's Dent corn fodder,	95.25	93.00
III.	Alfalfa hay, first cutting, third-year growth,	101.75	96.25
V.	Alfalfa hay, first cutting, first-year growth,	97.75	98.75
VII.	Clover hay, first cutting,	102.50	96.50

Sheep III.

II.	Wing's Improved White Cap fodder,	78.50	77.75
IV.	Alfalfa hay, second cutting, third-year growth,	93.25	89.50
VI.	Clover hay, second cutting,	93.75	91.75

Sheep IV.

II.	Wing's Improved White Cap fodder,	107.75	106.75
IV.	Alfalfa hay, second cutting, third-year growth,	112.75	110.50
VI.	Clover hay, second cutting,	113.75	111.50

Brewer's Dent Corn Fodder, Period I.

Sheep I.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
2,500 grams Brewer's Dent corn fodder fed,	484.75	25.79	47.70	116.05	287.94	7.27
146.04 grams manure excreted,	130.84	13.08	14.75	33.93	66.95	2.13
Grams digested,	353.91	12.71	32.95	82.12	220.99	5.14
Per cent. digested,	73.01	49.28	69.08	70.76	76.75	70.70

Sheep II.

2,500 grams Brewer's Dent corn fodder fed,	484.75	25.79	47.70	116.05	287.94	7.27
154.56 grams manure excreted,	138.66	14.56	15.07	38.48	68.05	2.50
Grams digested,	346.09	11.23	32.63	77.57	219.89	4.77
Per cent. digested,	71.40	43.54	68.41	66.84	76.37	65.61
Average per cent. for both sheep,	72.21	46.41	68.75	68.80	76.56	68.16

Wing's Improved White Cap Dent Corn Fodder, Period II.

Sheep III.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
2,500 grams White Cap Dent corn fodder fed,	479.50	23.26	44.88	108.28	295.56	7.52
162.08 grams manure excreted, ...	144.53	14.40	16.85	40.95	70.15	2.18
Grams digested, ...	334.97	8.86	28.03	67.33	225.41	5.34
Per cent. digested, ...	69.86	38.09	62.46	62.18	76.27	71.01

Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
2,500 grams White Cap Dent corn fodder fed,	479.50	23.26	44.88	108.28	295.56	7.52
155.55 grams manure excreted, ...	139.56	13.94	16.37	35.00	71.95	2.30
Grams digested, ...	339.94	9.32	28.51	73.28	223.61	5.22
Per cent. digested, ...	70.89	40.07	63.52	67.68	75.66	69.41
Average per cent. for both sheep, . .	70.38	39.08	62.99	64.93	75.97	70.21

Alfalfa Hay, First Cutting, Third-year Growth, Period III.

Sheep I.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
750 grams alfalfa hay fed, ...	640.65	48.37	106.46	193.22	280.49	12.11
222.06 grams manure excreted, . . .	203.25	20.59	23.07	89.22	63.68	6.69
Grams digested, ...	437.40	27.78	83.39	104.00	216.81	5.42
Per cent. digested, ...	68.27	57.43	78.33	53.82	77.30	44.76

Sheep II.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
750 grams alfalfa hay fed, ...	640.65	48.37	106.46	193.22	280.49	12.11
260.33 grams manure excreted, . . .	238.51	25.52	25.62	106.89	73.32	7.16
Grams digested, ...	402.14	22.85	80.84	86.33	207.17	4.95
Per cent. digested, ...	62.77	47.24	75.93	44.68	73.86	40.88
Average per cent. for both sheep, . .	65.52	52.34	77.13	49.25	75.58	42.82

Alfalfa Hay, Second Cutting, Third-year Growth, Period IV.

Sheep III.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
750 grams alfalfa hay fed, ...	650.63	43.59	99.61	247.43	251.61	8.39
318.04 grams manure excreted, . . .	297.40	28.16	30.42	143.02	88.57	7.23
Grams digested, ...	353.23	15.43	69.19	104.41	163.04	1.16
Per cent. digested, ...	54.29	35.40	69.46	42.20	64.79	13.83

Alfalfa Hay, Second Cutting, Third-year Growth, Period IV — Concluded.

Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
750 grams alfalfa hay fed,	659.25	44.17	100.93	250.71	254.94	8.50
285.99 grams manure excreted,	267.03	25.37	25.85	129.40	79.55	6.86
Grams digested,	392.22	18.80	75.08	121.31	175.39	1.64
Per cent. digested,	59.49	42.56	74.39	48.39	68.80	19.29
Average per cent. for both sheep,	56.89	38.98	71.93	45.30	66.80	16.56

Alfalfa Hay, First Cutting, First-year Growth, Period V.

Sheep I.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
800 grams alfalfa hay fed,	695.76	53.09	114.73	245.46	272.04	10.44
330.56 grams manure excreted,	310.33	32.31	34.17	140.07	95.80	7.98
Grams digested,	385.43	20.78	80.56	105.39	176.24	2.46
Per cent. digested,	55.40	39.14	70.22	42.94	64.78	23.56

Sheep II.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
800 grams alfalfa hay fed,	695.76	53.09	114.73	245.46	272.04	10.44
298.29 grams manure excreted,	280.00	28.95	30.91	125.97	86.41	7.76
Grams digested,	415.76	24.14	83.82	119.49	185.63	2.68
Per cent. digested,	59.76	45.47	73.06	48.68	68.24	25.67
Average per cent. for both sheep,	57.58	42.31	71.64	45.81	66.51	24.62

Clover Hay, Second Cutting, Period VI.

Sheep III.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
890 grams clover hay fed,	704.80	63.15	107.69	209.75	310.96	13.25
318.54 grams manure excreted,	296.40	29.25	43.81	119.00	98.38	5.96
Grams digested,	408.40	33.90	63.88	90.75	212.58	7.29
Per cent. digested,	57.94	53.68	59.32	43.27	68.36	55.02

Sheep IV.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
800 grams clover hay fed,	704.80	63.15	107.69	209.75	310.96	13.25
292.57 grams manure excreted,	272.70	26.53	42.43	106.17	91.71	5.86
Grams digested,	432.10	36.62	65.26	103.58	219.25	7.39
Per cent. digested,	61.31	57.99	60.60	49.38	70.51	55.77
Average per cent. for both sheep,	59.63	55.84	59.96	46.33	69.44	55.40

Clover Hay, First Cutting, Period VII.

Sheep I.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
800 grams clover hay fed,	709.20	79.57	126.38	200.70	288.65	13.90
270.50 grams manure excreted,	251.89	30.88	45.57	76.27	92.57	6.60
Grams digested,	457.31	48.69	80.81	124.43	196.08	7.30
Per cent. digested,	64.48	61.19	63.94	62.00	67.93	52.52

Sheep II.

	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
800 grams clover hay fed,	709.20	79.57	126.38	200.70	288.65	13.90
284.76 grams manure excreted,	265.45	32.23	45.74	86.14	94.70	6.64
Grams digested,	443.75	47.34	80.64	114.56	193.95	7.26
Per cent. digested,	62.57	59.49	63.81	57.08	67.19	52.23
Average per cent. for both sheep,	63.53	60.34	63.88	59.54	67.56	52.38

Summary of Coefficients (Per Cent.).

Food.	Sheep Number.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Brewer's Dent corn fodder,	Sheep I.,	73.01	49.28	69.08	70.76	76.75	70.70
	Sheep II.,	71.40	43.54	68.41	66.84	76.37	65 61
Average,		72.21	46.41	68.75	68.80	76.56	68.16
Wing's Improved White Cap Dent corn fodder.	Sheep III.,	69.86	38.09	62.46	62.18	76.27	71.01
	Sheep IV.,	70.89	40.07	63.52	67.68	75.66	69.41
Average,		70.38	39.08	62.99	64.93	75.97	70.21
Alfalfa hay,	Sheep I.,	68.27	57.43	78.33	53.82	77.30	44.76
	Sheep I.,	55.40	39.14	70.22	42.94	64.78	23.56
	Sheep II.,	65.52	52.34	77.13	49.25	75.58	42.82
	Sheep II.,	59.76	45.47	73.06	48.68	68.24	25.67
	Sheep III.,	54.29	35.40	69 46	42.20	64.79	13.83
	Sheep IV.,	59.49	42.56	74.39	48.39	68.80	19.29
Average,		60.46	45.39	73.77	47.55	69.92	28.32
Clover hay,	Sheep I.,	64 48	61.19	63.94	62.00	67.93	52.52
	Sheep II.,	62.57	59.49	63.81	57.08	67.19	52.23
	Sheep III.,	57.94	53.68	59.32	43.27	68.36	55.02
	Sheep IV.,	61.31	57.99	60.60	49 38	70.51	55 77
Average,		61 58	58.09	61.92	52.93	68.50	53.89

Discussion of the Results.

Brewer's Dent Corn Fodder. — This is a yellow dent corn believed to have been first bred in the middle west and improved by N. H. Brewer of Connecticut, who has raised enormous crops by following an intensive system of fertilization and cultivation. We have not been successful in ripening it on the station farm. At the time of cutting (September 5–19) the ears were hardly in milk, and consequently not suitable to harvest for grain. It evidently needs a somewhat longer growing season than is usually experienced in the vicinity of Amherst. It produced at the rate of about 18 tons of green fodder per acre, and yielded about 17 per cent. of ears in dry matter.

Summary of Coefficients, Period I. (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Sheep I., ...	1	1	73.01	49.28	69.08	70.76	76.75	70.70
Sheep II., ...	1	1	71.40	43.54	68.41	66.84	76.37	65.61
Average, ...	1	2	72.21	46.41	68.75	68.80	76.56	68.16
Average of all trials, immature dents for comparison.	5	14	68.00	42.00	66.00	65.00	71.00	68.00

The coefficients obtained in this trial are somewhat higher than the average for immature corn. While the percentage of ears was low, the high digestibility can probably be accounted for by the soft, incompletely developed stalks, the fiber showing a relatively high digestibility.

Wing's Improved White Cap Dent Corn Fodder. — This variety of corn was originated by J. E. Wing of Ohio. It would probably form a very satisfactory variety in the middle west, but the season is not sufficiently long to enable it to reach maturity in New England. Two partially developed ears were frequently noticed on a stalk. When cut (September 5–19) it was in milk and still green. It yielded at the rate of about 14 tons of green fodder per acre, and contained 16 per cent. of ears in its dry matter.

Summary of Coefficients, Period II. (Per Cent.).

Sheep.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Sheep III.,	1	1	69.86	38.09	62.46	62.18	76.27	71.01
Sheep IV.,	1	1	70.89	40.07	63.52	67.68	75.66	69.41
Average,	1	2	70.38	39.08	62.99	64.93	75.97	70.21
Average of all trials, immature dents for comparison.	5	14	68.00	42.00	66.00	65.00	71.00	68.00

This corn is of substantially the same type as the one immediately preceding. It appeared to be slightly less digestible. although the difference may have been partly due to the individuality of the two lots of sheep.

Alfalfa Hay. — The alfalfa hay used in these experiments was grown on the college farm. It was cut while in early blossom, and was quite free from weeds and grass. Period III. represented the first cutting of the third-year growth, period IV. the second cutting of the third-year growth, and period V. the first cutting of the first-year growth. Owing to different weather conditions which prevailed at the time of cutting, and which necessitated different methods of handling, the amount of leaves lost in curing was not uniform; hence a strictly fair comparison could not be made between the different cuttings. The results are therefore reported together, and the average given for the several lots. In order to draw accurate conclusions between cuttings, the crop should either be fed green or cured under uniform conditions. Owing to frequent weather changes this is often not possible in New England.

Summary of Coefficients, Periods III., IV. and V. (Per Cent.).

SHEEP.	Cutting.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Sheep I.,	1[1]	1	1	68.27	57.43	78.33	53.82	77.30	44.76
Sheep I.,	1[2]	1	1	55.40	39.14	70.22	42.94	64.78	23.56
Sheep II.,	1[1]	1	1	62.77	47.24	75.93	44.68	73.86	40.88
Sheep II.,	1[2]	1	1	59.76	45.47	73.06	48.68	68.24	25.67
Sheep III.,	2[1]	1	1	54.29	35.40	69.46	42.20	64.79	13.83
Sheep IV.,	2[1]	1	1	59.49	42.56	74.39	48.39	68.80	19.29
Average,	–	3	6	60.00	44.54	73.57	46.79	69.63	28.00
Average of all trials, alfalfa hay for comparison.	–	42	80	62.00	50.00	74.00	46.00	72.00	40.00
Average of all trials, red clover for comparison.	–	12	25	58.00	36.00	58.00	54.00	65.00	56.00

Unfortunately an exact record of the conditions during the curing process of the several lots was not kept. It would appear that the first cutting of the *third-year growth* was cured without the loss of a great deal of leafy matter. This is shown by the relatively low fiber percentage and the high digestibility. The second cutting of the *third-year growth* evidently lost a considerable portion of its leaves, as indicated by its high fiber percentage and lessened digestibility. The first cutting of the *first-year growth* also must have lost an excess of leaves, as it also shows excessive fiber and low digestion coefficients. It is possible that the tags of the first cutting, third-year growth and the first cutting first-year growth, were reversed, although we have not the slightest evidence to that effect.

While the coefficients obtained vary considerably the average is about the same as the average for all trials, except that the coefficient for fat is somewhat lower. It is believed that the average coefficients obtained in our several trials show fairly the digestibility of eastern grown alfalfa under the adverse conditions due to the loss of leaves in the process of curing.

Red Clover Hay. — The clover was seeded in early August the year previous. It yielded well, was in early blossom when

[1] Third-year growth. [2] First-year growth.

cut, and was cured in cocks. The first cutting did not cure out well, owing to a rainy spell during the curing process. It had a black appearance when taken to the barn, and later had to be spread in the sun for further drying. It did not lose its leaves to any extent. The lot was lacking in a satisfactory odor and was slightly musty. The conditions during the curing of the second cutting were more favorable. Both lots were rich in protein (15.28 and 17.82 per cent. in dry matter) and comparatively low in fiber (29.76 and 28.30 per cent. in dry matter).

Summary of Coefficients, Periods VI. and VII. (Per Cent.).

SHEEP.	Cutting.	Number of Different Lots.	Single Trials.	Dry Matter.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Sheep I.,	1	1	1	64.48	61.19	63.94	62.00	67.93	52.52
Sheep II.,	1	1	1	62.57	59.49	63.81	57.08	67.19	52.23
Sheep III.,	2	1	1	57.94	53.68	59.32	43.27	68.36	55.02
Sheep IV.,	2	1	1	61.31	57.99	60.60	49.38	70.51	55.77
Average,	–	2	4	61.58	58.09	61.92	52.93	68.50	53.89
Average alfalfa hay (our trials).	–	3	6	60.46	45.39	73.77	47.55	69.92	28.32
Average of all trials, clover hay for comparison.	–	12	25	58.00	36.00	58.00	54.00	65.00	56.00
Average of all trials, alfalfa hay for comparison.	–	42	80	62.00	50.00	74.00	46.00	72.00	40.00

The most noticeable difference in the four single trials with clover hay consists in the variation in the digestion coefficients obtained for the fiber (43–62). This is evidently due, in part at least, to the individuality of the several animals. The fiber in the second cutting was apparently not as digestible as in the first cutting. The other coefficients — excepting the ash, which is found to vary widely in most all experiments — may be considered fairly uniform. The coefficients secured by us are higher than the average for all experiments, probably due to the early cuttings of the crop. When the clover coefficients are compared with our reported experiments for alfalfa, it is noted that in case of the total dry matter, the former shows to advantage, although the reverse is true in a comparison of the

experiments reported for all trials. The protein in the clover is shown to be substantially 12 per cent. less digestible than in the alfalfa; the coefficients vary 16 per cent. in case of the average for all trials. In case of the fiber the conditions are reversed, differences of from 5 to 8 points being noted in favor of the clover. The comparative digestibility of the extract matter is about the same, although the average figures show 7 points in favor of the alfalfa. In making a comparison of the two plants from the standpoint of digestibility, two important differences are noted: (1) the protein in the alfalfa is noticeably more digestible than in the clover (12 to 16 points), and (2) the fiber from 5 to 8 points less so. In total digested the two plants approach each other, showing an average of about 60 per cent. as against 55 per cent. for timothy, 60 per cent. for early cut fine hay, 65 per cent. for rowen, 70 per cent. for the entire corn plant, and 85 per cent. for corn meal.

It is evident that the relative value of the two crops cannot be determined from their digestibility alone; other important factors to be considered are cost of production, yield and adaptability to Massachusetts conditions. Taking all the evidence into consideration, it would appear that although the cost of seed and preparation of land is somewhat against the alfalfa, yet its much greater length of life, its larger average annual yield, and its rather superior nutritive value are all in its favor. The conditions governing its successful cultivation must be carefully studied by all interested in its production. To the lack of attention to these conditions by the average farmer is due in no small measure the failures reported.

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